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PHASE I

Geology, Energy and Mineral (GEM) Resource Assessment of the Mt. Bennett Hills GRA, Idaho, including the Little City of Rocks (54-5), Black Canyon (54-6), Gooding (54-8a), City of Rocks (54-8b), Deer Creek (54-10) and King Hill Creek (19-2) Wilderness Study Areas

Bureau of Land Management
Contract No. YA-553-CT2-1039

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ANCHORAGE, ALASKA
SEPTEMBER 1983

WGM INC.
MINING AND GEOLOGICAL CONSULTANTS

EXECUTIVE SUMMARY

The Mt. Bennett Hills Geology, Energy and Mineral Resource Area (GRA) is located south of Camas Prairie in Camas, Gooding and Elmore Counties, Idaho. The area includes six BLM Wilderness Study Areas. These are the Little Rocks (54-5), Black Canyon (54-6), Gooding (54-8a), City of Rocks (54-8b) and Deer Creek (54-10) WSAs in the Bennett Hills Resource Area, Shoshone district, and the King Hill Creek (19-2) WSA in the Cascade Resource Area, Boise district.

Bedrock in the Mt. Bennett Hills GRA consists of young volcanic rocks and interbedded sedimentary rocks. There are a few exposures of crystalline intrusive rocks in the northern part of the area. The six WSAs are entirely underlain by volcanic rocks.

The amount of data available for the Mt. Bennett Hills GRA is limited. There is no geochemical data, and very little information on oil and gas resources or salable resources. A moderate amount of data is available on geothermal resources. Consequently, the level of confidence of many of the land classifications is low.

There is a small gold district north of the King Hill Creek WSA but otherwise there are virtually no known metallic mineral occurrences in the area. Diatomite deposits are present in the Gooding and City of Rocks WSAs and may be present in other areas. These deposits are presently being evaluated by private industry. There are six warm or hot springs in the area and several

WSAs, particularly King Hills Creek WSA, are in potential geothermal resource areas. One dry oil and gas well was drilled west of the GRA but there are no exploration wells within the GRA.

The best resource potential in the WSAs is for diatomite deposits and geothermal resources. Portions of the Gooding (54-8a), City of Rocks (54-8b), Deer Creek (54-10), and King Hill Creek (19-2) WSAs have moderate to high potential for the occurrence of diatomite deposits. The King Hill Creek (19-2) WSA has high potential for low temperature geothermal resources and moderate potential for high temperature geothermal resources. The other five WSAs have moderate to high potential for low temperature geothermal resources. The potential for metallic minerals, uranium, oil and gas, and salable resources within the WSAs is considered low, however the confidence in most of these classifications is low.

MT. BENNETT HILLS GRA

SUMMARY OF GEM RESOURCES CLASSIFICATION

Resource	Wilderness Study Areas					
	54-5	54-6	54-8a	58-8b	54-10	19-2
Locatable						
Metallic	2B	2B	2B	2B	2B	2B
Uranium-Thorium	2B	2B	2B	2B	2B	2B
Non-Metallic	2C	2C	4D	4D	4D	3C/2C
Leasable						
Oil and Gas	2A	2A	2A	2A	2A	2A
Geothermal (L)	3B-4B	3B-4B	3B-4B	3B-4B	3B	4B
Geothermal (11)	2A-3A	2A-3A	2A-3A	2A-3A	2A	3B
Sodium-Potassium	2C	2C	2C	2C	2C	2C
Other	2C	2C	2C	2C	2C	2C
Saleable	2A	2A	2A	2A	2A	2A

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MT. BENNETT HILLS GRA

1.0 INTRODUCTION

The Bureau of Land Management has adopted a two-phase procedure for the integration of geological, energy and minerals (GEM) resources data into the suitable/non-suitable decision-making process for Wilderness Study Area (WSAs). The objective of Phase I is the evaluation of existing data, both published and available unpublished data, for interpretation of the GEM resources potential of the WSAs. Wilderness Study Areas are grouped into areas based on geologic environment and mineral resources for initial evaluation. These areas are referred to as Geology, Energy, Mineral Resource Areas (GRAs).

The delineation of the GRAs is based on three criteria: (1) a 1:250,000 scale map of each GRA shall be no greater than 8½ x 11 inches: (2) a GRA boundary will not cut across a Wilderness Study Area; and (3) the geologic environment and mineral occurrences. The data for each GRA is collected, compiled, and evaluated and a report prepared for each GRA. Each WSA in the GRA is then classified according to GEM resources favorability. The classification system and report format are specified by the BLM to maintain continuity between regions.

This report is prepared for the Bureau of Land Management under contract number YA-553-CT2-1039. The contract covers GEM Region 2; Northern Rocky Mountains (Fig. 1). The Region includes 50 BLM Wilderness Study Areas

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BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Mount Bennett Hills GRA, Idaho Location Map

SCALE 1" = 45 MILES			FIGURE 1
DATA BY WGM	DATE 12/1982	REVISED	
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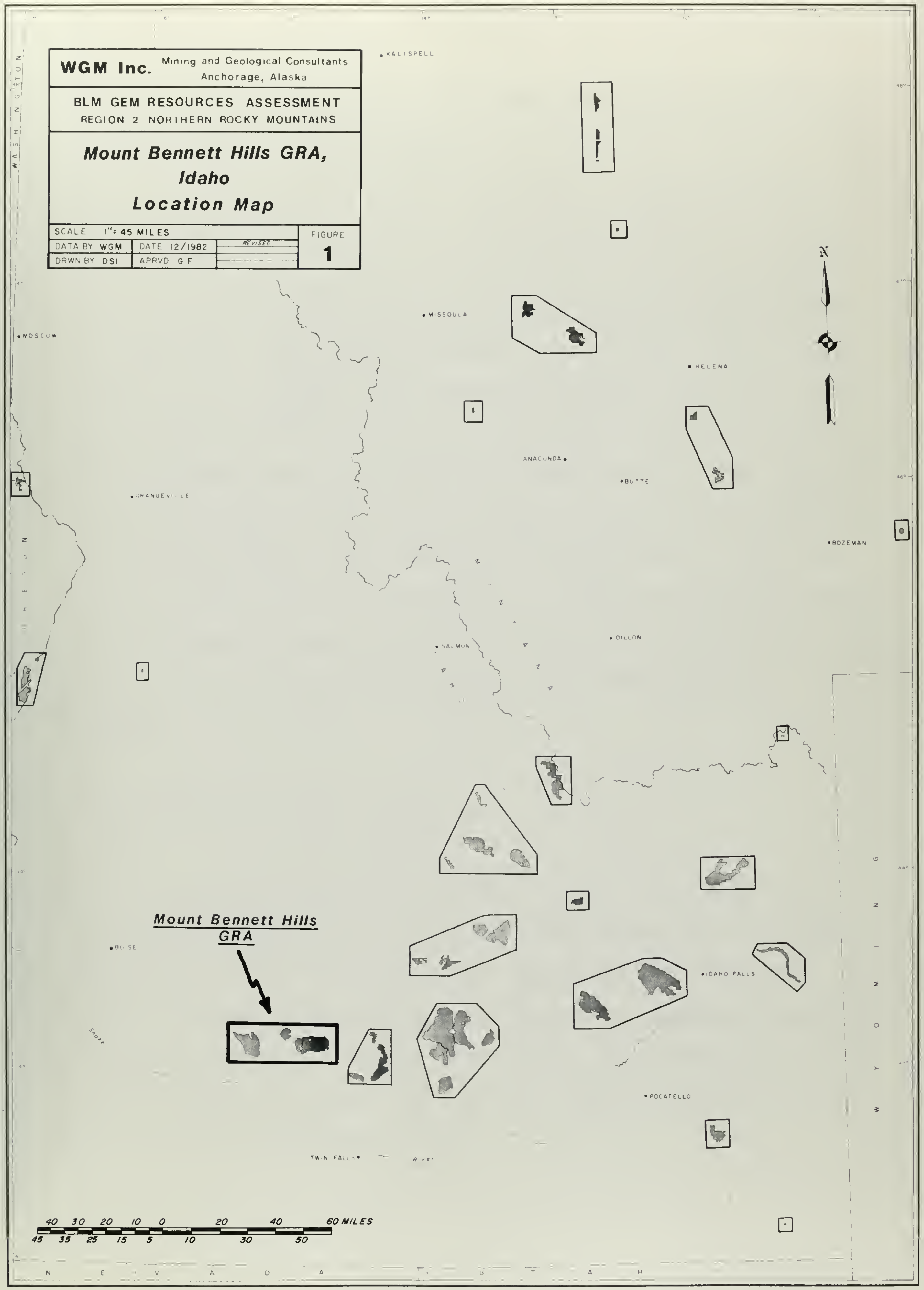


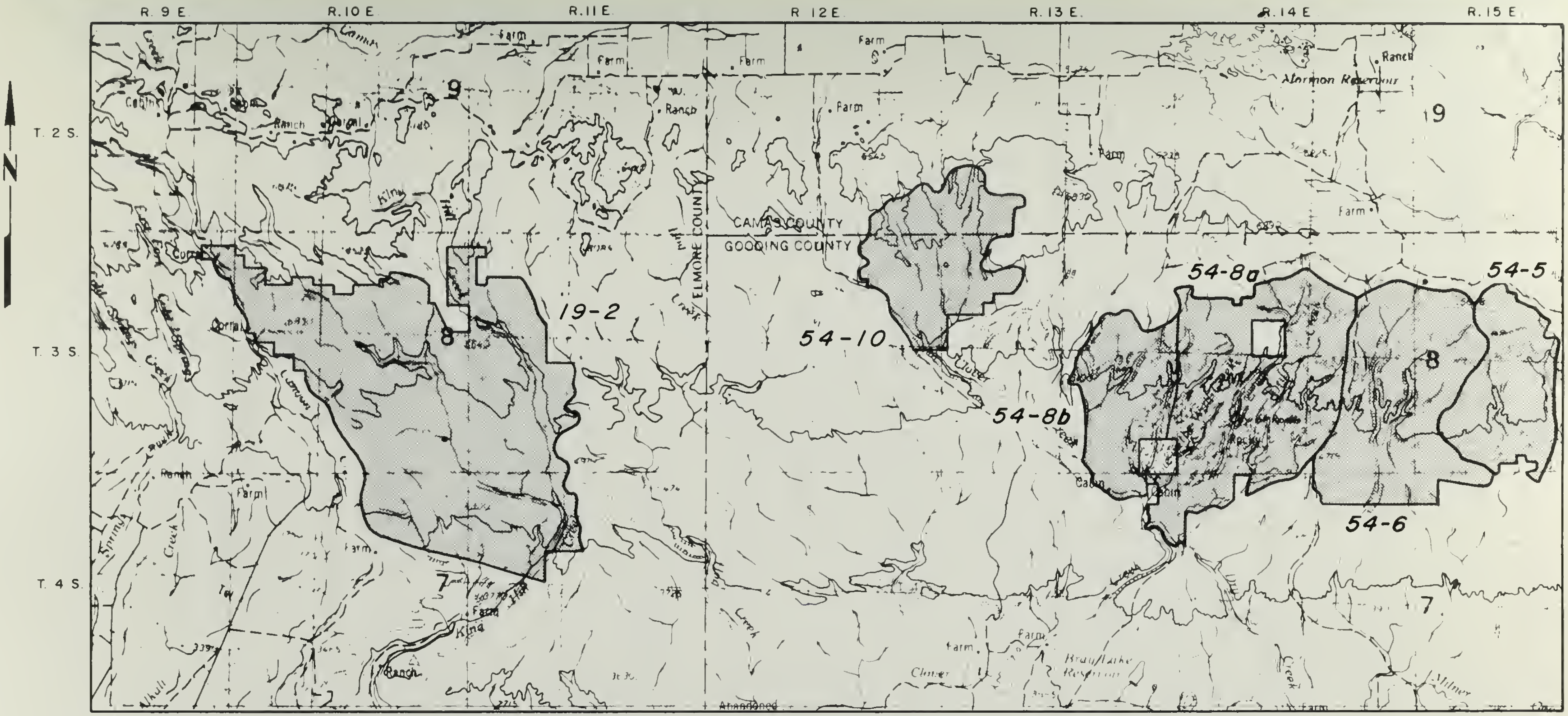
totalling 583,182 acres. The WSAs were grouped into 22 GRAs for purposes of the Phase I GEM resources evaluation.

1.1 Location

The Mt. Bennett Hills GRA is located in Elmore, Camas and Gooding Counties in south-central Idaho (Fig. 2). The GRA is in the Hailey NTMS Quadrangle within Ts.2-4S., Rs.9-15E. and it covers approximately 1,540 square miles. The Mt. Bennett Hills GRA includes six BLM Wilderness Study Areas (WSAs) totalling 68,578 acres: (1) Little City of Rocks (54-5) - 5,875 acres, (2) Black Canyon (54-6) - 10,371 acres, (3) Gooding (54-8a) - 14,743 acres, (4) City of Rocks (54-86) - 6,287 acres, (5) Deer Creek (54-10) - 7,487 acres, and (6) King Hill Creek (19-2) 23,815 acres. The King Hill Creek WSA (19-2) is in the Cascade Resource Area of the Boise BLM district and the other five WSAs are within the Bennett Hills Resource Area of the Shoshone BLM district.

1.2 Population and Infrastructure

There are no towns within the Mt. Bennett Hills GRA. The closest towns, Fairfield and Gooding, are just north and south, respectively, of the GRA. Mountain Home, Idaho is located 12 miles west of the GRA. Idaho State Highway 46 traverses the eastern edge of the GRA. In addition, Idaho State Highway 68 is about five miles north of the GRA and U.S. Highway 26 is about five miles south of the GRA. Gravel and dirt roads cross much of the area and follow many of the stream valleys.



BLM Wilderness Study Areas Included in the Mount Bennett Hills GRA.

WSA	NAME	ACREAGE
54-5	Little City of Rocks	5,875
54-6	Black Canyon	10,371
54-8a	Gooding	14,743
54-8b	City of Rocks	6,287
54-10	Deer Creek	7,487
19-2	King Hill Creek	23,815

▨ Approximate Boundary of Wilderness Study Area.

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BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Mount Bennett Hills GRA,
Idaho
Topographic Map

SCALE: 1" = 4 MILES (1:250,000)
DATA BY: WGM DATE: 9/1982 REVISED
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FIGURE 2

1.3 Basis of the Report

This report is based on a compilation, review, and analysis of available published and unpublished data on the geology, energy, and mineral resources of the Mt. Bennett Hills GRA. The major sources of data were published geologic maps by the U.S. Geological Survey, university theses, and mineral and energy compilations by the Idaho Bureau of Mines. The data was compiled and reviewed by WGM project personnel and the Panel of Experts to produce the resource evaluation which comprises this report. Personnel are as follows:

Greg Fernette, Senior Geologist, WGM Inc.	Project Manager
C.G. Bigelow, President, WGM Inc.	Chairman, Panel of Experts
Joel Stratman, Geologist, WGM Inc.	Project Geologist
Jami Fernette, Land and Environmental Coordinator, WGM Inc.	Claims and Lease Compilation

Panel of Experts

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David Blackwell, Ph.D., Professor of Geophysics, Southern Methodist University	Geothermal.
Jason Bressler, Senior Geologist, WGM Inc.	Regional geology, metallic minerals.
Gary Webster, Ph.D., Chairman, Department of Geology, Washington State University	Oil and gas.
William Jones, Senior Geologist, WGM Inc.	Metallic minerals, coal, industrial minerals.

J.F. McOuat, President, Watts, Griffis & McOuat Ltd.	Mineral economics, and industrial minerals.
E.F. Evoy, Senior Geologist, Watts, Griffis & McOuat Ltd.	Uranium and thorium.

1.4 Acknowledgements

We would like to thank Larry Dee, District Geologist, at the Shoshone BLM office and Fred Anderson, District Geologist at the Boise BLM office, for assistance during the compilation phase of this project and for loaning us publications and areal photos pertaining to the Mt. Bennett Hills GRA.

2.0 GEOLOGY

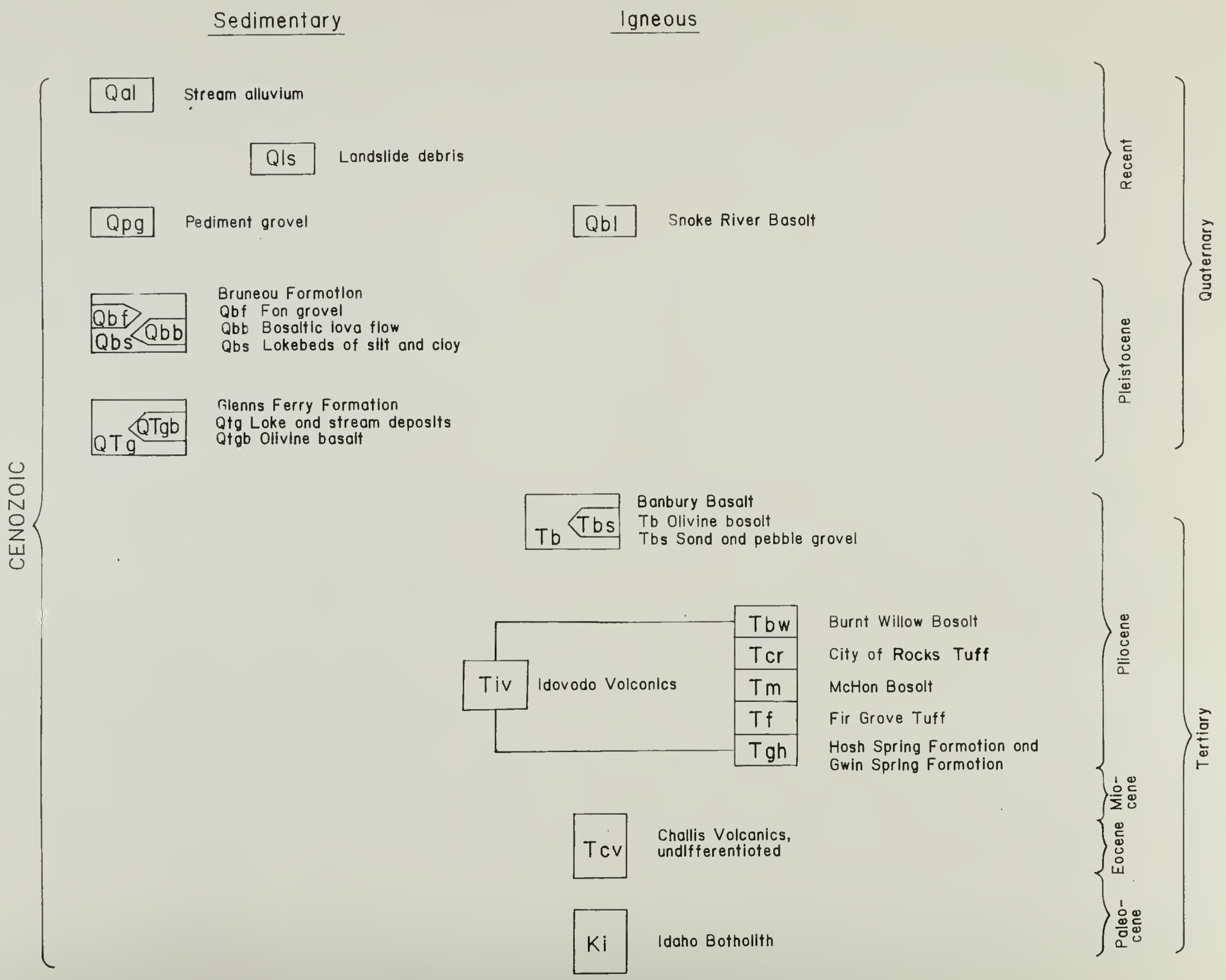
2.1 Introduction

The bedrock underlying the Mt. Bennett Hills GRA consists mainly of Cenozoic (65 m.y. to present) volcanics (Figs. 3 and 4). The volcanics overlie Cretaceous (141-65 m.y.) intrusives belonging to the Idaho batholith. The area is located on the northern edge of the Snake River Plain, but it includes tectonic elements characteristic of both the Snake River Plain and the Idaho batholith. Geologic mapping in the area includes work by Malde and Powers (1972), Malde et al. (1963), Walton (1962) and Stearns et al. (1938) of the U.S. Geological Survey and theses by Smith (1966), and Schmidt (1960). The geology of the entire area was compiled at 1:250,000 scale by Rember and Bennett (1979).

2.2 Physiography

The Mt. Bennett Hills GRA is in the Columbia Plateau-Snake River Plain physiographic province (Fig. 5; Hunt, 1974). The dominant physiographic feature in the area, the Mt. Bennett Hills, form an east-west-trending range of rounded hills which rise 1,500 to 1,800 feet above the surrounding lowlands (Fig. 2). The hills slope to the south and have a steep, structurally controlled (Smith, 1966) northern slope. Streams in the northern part of the GRA drain eastward along Camas Prairie. Most of the drainage, however, is southeast along a partially structurally controlled dendritic drainage system.

Mount Bennett Hills GRA, Idaho
Explanation for Figure 3



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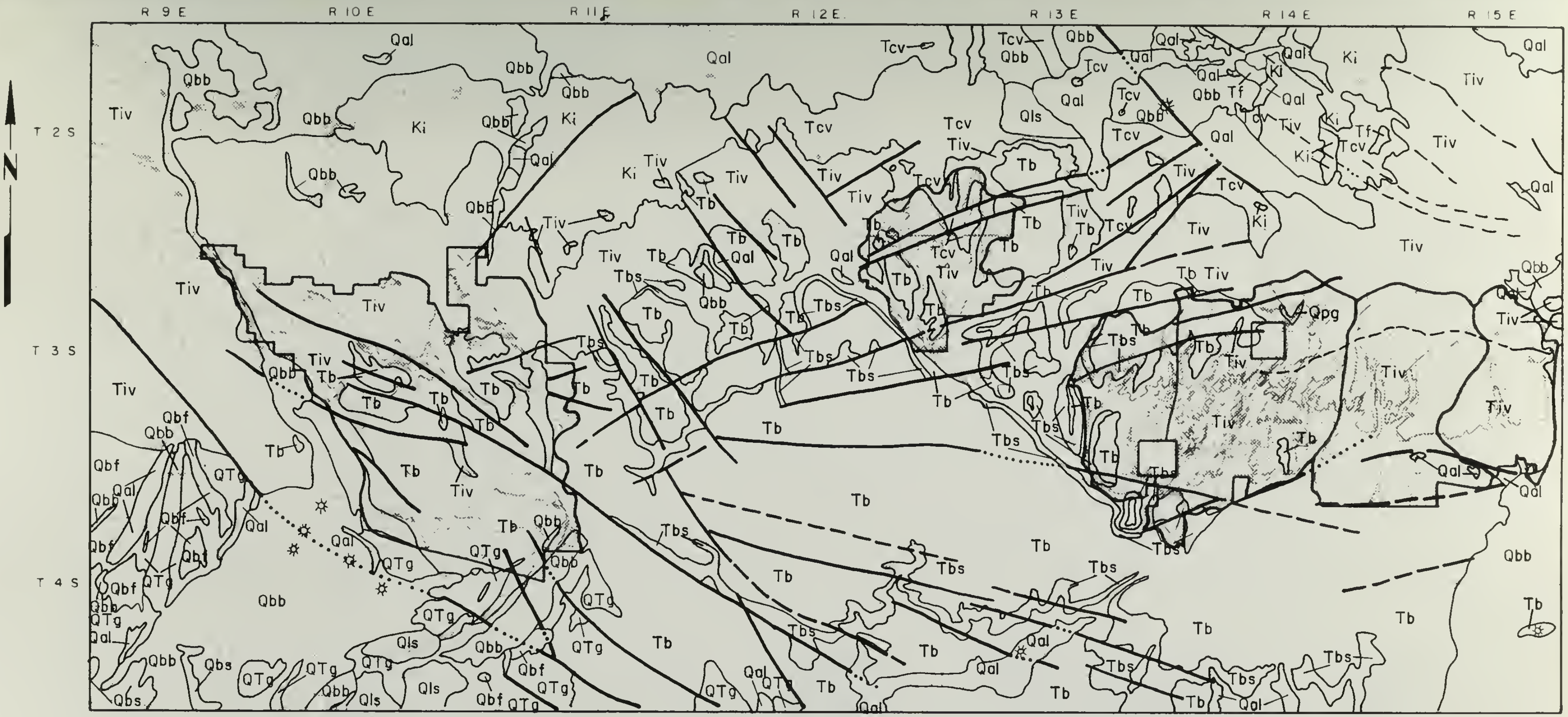
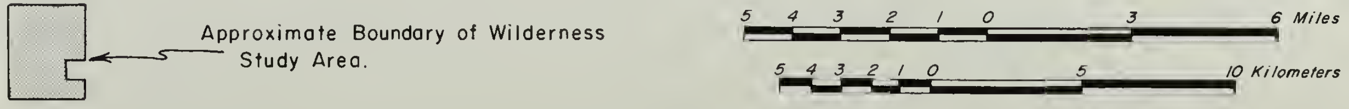


Source: Rember and Bennett, 1979



Approximate Boundary of Wilderness Study Area.

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REGION 2 NORTHERN ROCKY MOUNTAINS

Mount Bennett Hills GRA, Idaho

Geologic Map

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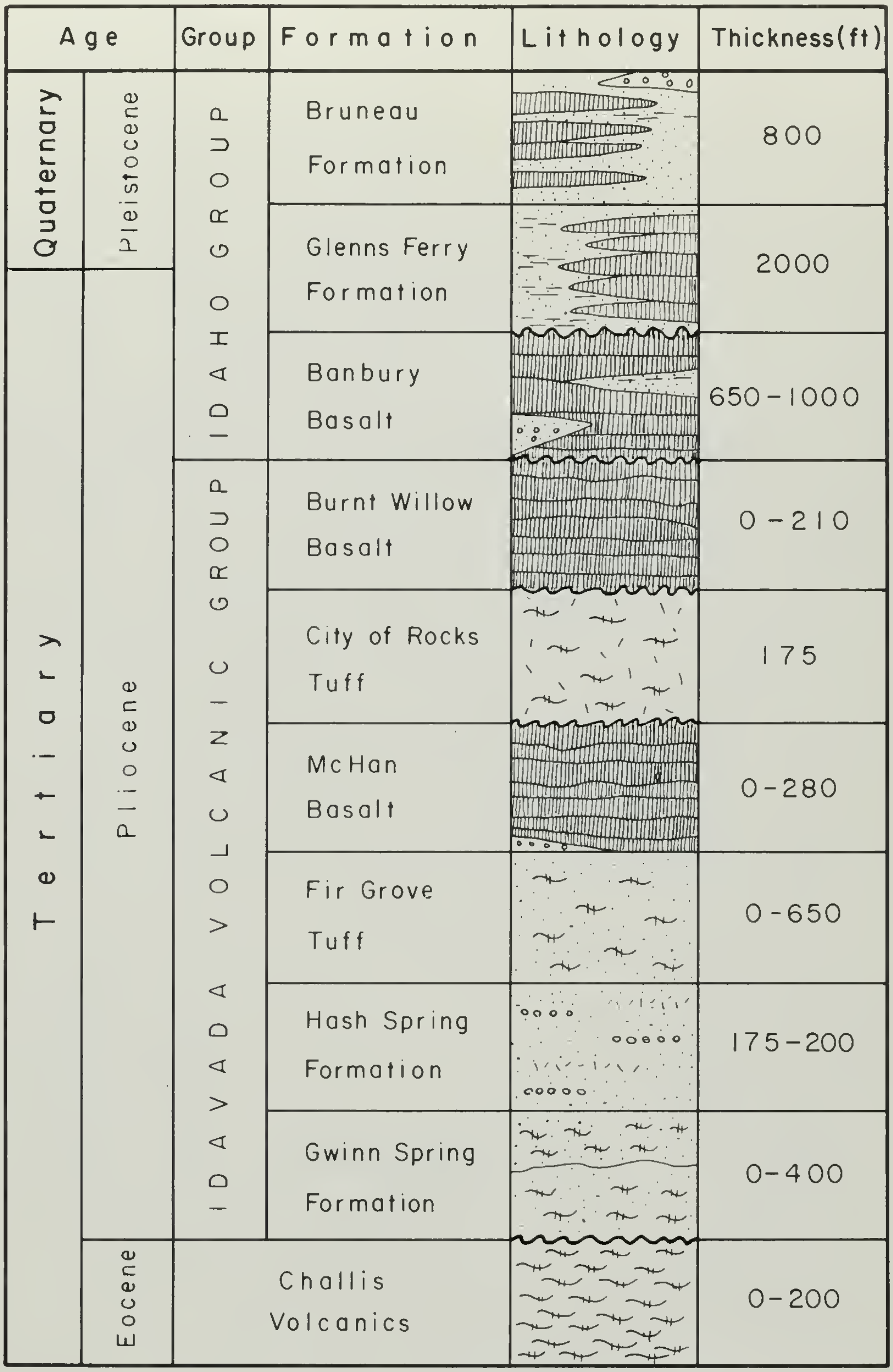

Age		Group	Formation	Lithology	Thickness(ft)
Quaternary	Pleistocene	IDAHO GROUP	Bruneau Formation		800
			Glenns Ferry Formation		2000
Tertiary	Pliocene		Banbury Basalt		650-1000
		IDAVADA VOLCANIC GROUP	Burnt Willow Basalt		0-210
			City of Rocks Tuff		175
			McHan Basalt		0-280
			Fir Grove Tuff		0-650
			Hash Spring Formation		175-200
			Gwinn Spring Formation		0-400
	Eocene	Challis Volcanics			0-200

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REGION 2 NORTHERN ROCKY MOUNTAINS

Mount. Bennett Hills GRA, Idaho
Stratigraphic Column

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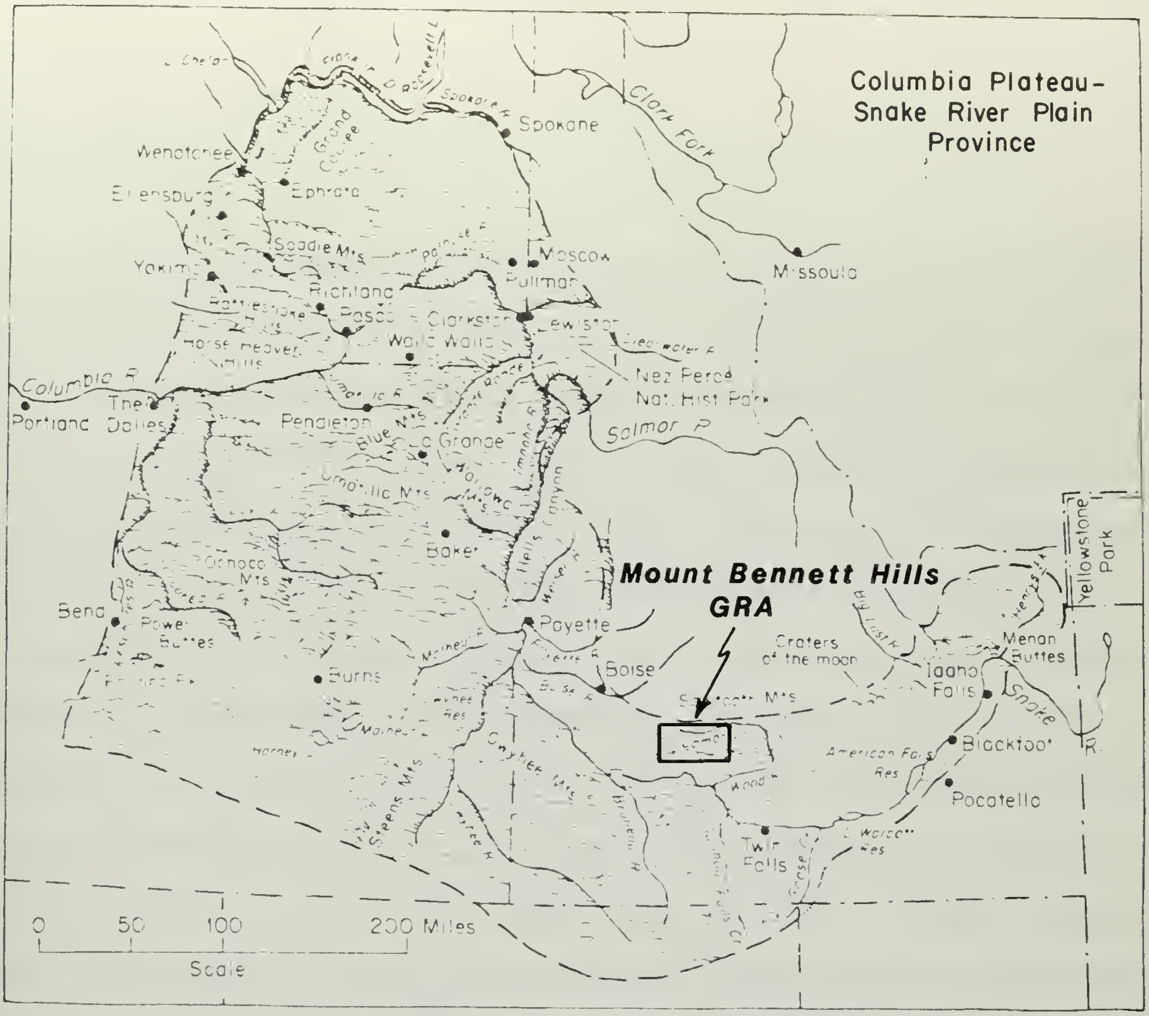

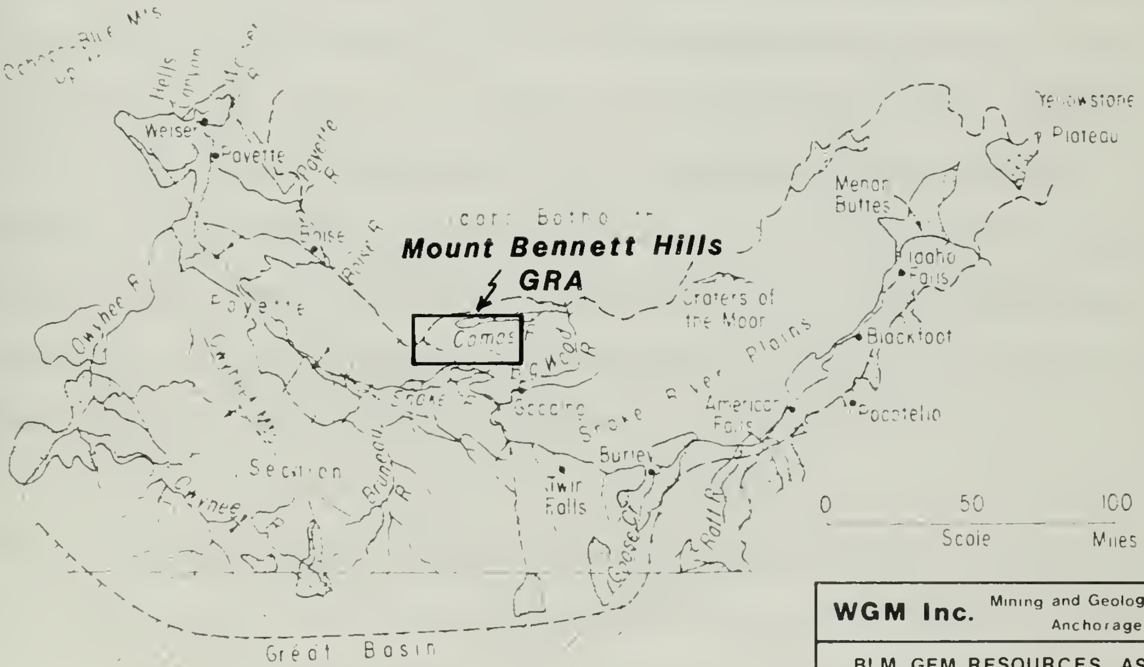

☐ Cenozoic Lake, Playa, and stream deposits.

☐ Lava

From Hunt (1974).

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BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Mount Bennett Hills GRA,
Idaho
Physiographic Setting

SCALE AS SHOWN			FIGURE
DATA BY WGM	DATE 3/1983	REVISED	5
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2.3 Rock Units

The oldest rocks exposed in the Mt. Bennett Hills GRA are plutonic rocks belonging to the Idaho batholith (Fig. 3). These rocks crop out in the northeastern part of the GRA and in the north-central part of the GRA. The rocks in the northeast outcrop area are deeply weathered pinkish-tan, weakly porphyritic, biotite granite (Smith, 1966). The granite is sheared and fractured. Gouge is developed along the shears and bleaching and clay alteration along the shear margins. Most of the fractures are limonite stained and some contain quartz veinlets. Smith observed no sulfide minerals. The north-central outcrop area includes the Volcano gold mining district described by Allen (1940, 1952) and is underlain by predominantly coarse-grained, gray to white, quartz monzonite that is somewhat porphyritic. Numerous aplite and granophyre dikes intrude the quartz monzonite. The plutonic rocks in the Mt. Bennett Hills GRA are probably part of the Atlanta lobe of the Idaho batholith and were emplaced 75 to 100 m.y. ago (Armstrong et al., 1977). The aplite and granophyre dikes are probably Tertiary (65-2 m.y.) age (Allen, 1952). Regional structural evidence suggests that batholith extends to the south beneath the overlying Cenozoic volcanic rocks (Taubeneck, 1971). The plutonic rocks are unconformably overlain by Cenozoic volcanic rocks, including the Challis volcanics, the Banbury Basalt, and the Idavada Volcanics.

The Challis Volcanics crop out on the north flank of the Mt. Bennett Hills (Fig. 3). These rocks are part of an extensive Cenozoic field in central Idaho (Siems and Jones, 1977). Within the Mt. Bennett Hills GRA the Challis

Volcanics consist almost entirely of hornblende latite and hornblende andesite lava flows (Smith, 1966). The lavas are brown, purple and green, and they form knobby, low outcrops. Welded tuff and volcanic breccia occur locally. Smith reports the occurrence of petrified wood in a few locales. The Challis Volcanics are Eocene (51 to 45 m.y.) in age (Protska et al., 1977) and may represent the early ejecta above the magma chambers which formed Tertiary plutons (Bennett, 1980).

The Idavada Group of volcanics unconformably overlie the Challis Volcanics and the plutonic rocks of the Idaho batholith. This group is composed of about 1,500 feet of dacitic, latitic and rhyolitic ignimbrites, basalts and arkosic gravels (Smith, 1966; Malde and Powers, 1962). The unit has been described in detail by Smith (1966) who recognized ten, interbedded, lenticular mappable units (formations), six of which are used by Rember and Bennett (1979) in their regional compilation. These six formations are: (1) the Gwin Spring Formation, (2) the Hash Spring Formation, (3) the Fir Grove Tuff, (4) the McHan Basalt, (5) the City of Rocks Tuff, and (6) the Burnt Willow Basalt. Paleontologic and stratigraphic evidence indicate that the Idavada volcanics are early Pliocene (6-4 m.y.) in age (Malde and Powers, 1962: Axelrod, 1964).

The lowest unit in the Idavada Group is the Gwin Spring Formation. It consists of two ignimbrite flows ranging from 0 to 400 feet thick. The ignimbrites are composed of latitic vitric-crystal welded tuffs, with well developed basal zones of welded vitrophyre. Oligoclase and pyroxene are the most common phenocrysts (Smith, 1966).

The Hash Spring Formation overlies the Gwin Spring ignimbrites. The contact is generally conformable or slightly unconformable. The Hash Spring averages 175 to 200 feet in thickness. The unit is an extensive sheet of interbedded arkosic gravels, waterlain ash and ash-breccia. The rocks are predominantly of fluvial origin. The clasts in the gravel are composed mainly of volcanic and plutonic igneous rocks. The ash units are composed of white to buff, fine- to coarse-grained, vitric-crystal ash with variable amounts of granitic clastic debris (Smith, 1966).

The Fir Grove Tuff overlies the Hash Spring and Gwin Spring Formations and outcrops in the northeast part of the Mt. Bennett Hills GRA. It ranges from 0 to over 650 feet in thickness and averages about 175 feet thick (Smith, 1966). The unit is composed of a compound cooling unit (Smith, 1960) of two or more ignimbrite sheets of latitic vitric-crystal to vitric composition. The Fir Grove is compositionally and texturally similar to the Gwin Spring Formation but has a less pronounced basal glassy zone (Smith, 1966).

The McHan Basalt is a sequence of several flows which conformably overlie the Fir Grove Tuff and Hash Spring Formation. The flows have a total thickness ranging from 0 to 280 feet and averaging 50 to 150 feet. The unit is composed of blue-gray porphyritic olivine basalt with diktytaxitic and glomeroporphyritic textures. Plagioclase and olivine phenocrysts are abundant. The basalts are often vesicular particularly near the tops of flows. The bottoms of the flows are locally auto-brecciated (Smith, 1966).

The McHan Basalt and other older units, including the Challis Volcanics are unconformably overlain by a single dacitic crystal welded tuff unit named

the City of Rocks Tuff. The formation consists of a basal vitrophyre zone and a thick welded zone which averages 175 feet in thickness. The tuff forms distinctive outcrops of large, rounded monoliths bounded by joints. The columns are deeply weathered at the base, resulting in a distinctive pedestal shape. The rock is a purple-gray dacite with abundant white plagioclase phenocrysts, and pronounced eutaxitic structure. The basal zone is composed of columnar jointed porphyritic vitrophyre. The upper dacitic portion of the unit displays good lamination and is generally folded (Smith, 1966).

The Burnt Willow Basalt comprises several basalt flows which unconformably overlie the McHan Basalt and other older units. The basalts range from 0 to 210 feet in aggregate thickness and average 30 feet thick. Lithologically the Burnt Willow Formation is similar to the McHan. It is composed of vesicular, porphyritic, olivine basalt with diktytaxitic and glomeroprophyritic textures. However it is much less weathered than the McHan Basalt (Smith, 1966).

The Idavada volcanics are unconformably overlain by the Idaho Group which consists of (1) the Banbury Basalt, (2) the Glenns Ferry Formation, and (3) the Bruneau Formation (Malde and Powers, 1962). The Banbury Basalt consists of a sequence of lava flows locally interbedded with stream and lake sediments. The unit ranges from 650 to 1,000 feet in thickness and is mid-Pliocene in age. The flows are composed of olivine basalt and lesser porphyritic, plagioclase-olivine basalt. Individual flows have a columnar and vesicular texture and are 15 to 50 feet thick. The interbdded sediments are largely brown sand and pebble gravel in lenticular stream channel

deposits. Lake sediments, principally silt, clay and diatomite are also present (Malde and Powers, 1972). Some of the diatomite deposits are currently being evaluated for industrial use by private industry (Treco Industries, 1974; L. Dee pers. comm., 1982).

The Banbury Basalt is unconformably overlain by the Glenns Ferry Formation comprising a basin fill unit of poorly consolidated sediments and intercalated basalt flows (Malde and Powers, 1962). The unit totals about 2,000 feet in thickness. It is upper Pliocene to lower Pleistocene (2-0.1 m.y.) in age based on K-Ar dating (Evernden et al., 1964). The lake and stream sediments exhibit abrupt lateral facies changes (Malde and Powers, 1972). The principal facies are banded silt, evenly bedded sand to sandstone, thin bedded dark clay, silt and carbonaceous shale, ripple marked sand and silt, granitic sand and gravel, and quartzitic gravel. Malde and Powers (1972) recognize five lava flows intertongued with the sediments. These are subareal flows, 50 to 100 feet thick, composed of olivine-plagioclase basalt with common basal units of palagonitized basaltic ash.

The youngest volcanic unit exposed in the Mt. Bennett Hills GRA is the middle Pleistocene Bruneau Formation. The Bruneau is a canyon fill unit composed of consolidated sediments and basaltic lava flows which unconformablie overlie the Glenns Ferry Formation (Malde and Powers, 1972). The sedimentary material consists mainly of light colored clay, silt and diatomite with minor alluvial sand and gravel. At least five basalt flow sequences are interlayered with the sediments. These are composed of porphyritic to aphanitic, fine- to medium-grained, plagioclase-olivine basalt (Smith, 1966). The flows range from 25 to 75 feet in thickness and

are generally basaltic in composition but locally are more alkalic (Powers, 1960). Mammalian fossils are common in the sediments (Malde and Powers, 1962) and together with K-Ar dates can be used to define the stratigraphy in detail (Evernden et al., 1964).

Holocene (0.1 m.y. to present) stream alluvium, pediment gravel and landslide debris comprise the major surficial deposits present in the Mt. Bennett Hills GRA.

2.4 Structural Geology and Tectonics

The Mt. Bennett Hills GRA is located on the northern edge of the Snake River Plain in an area where the Cenozoic volcanic rocks overlap the Idaho batholith (Taubeneck, 1971). The area is a complexly-faulted, southeasterly dipping horst bounded by the Camas Prairie graben on the north (Walton, 1962) and the Snake River Plain downwarp to the south (Smith, 1966). Gravity data (Bonini and Lavin, 1957, Mabey, 1976) and regional geologic studies (Malde et al., 1963) indicate an east-west trending zone of high angle faulting with apparent displacements of up to 9,000 feet along the margin of the Snake River Plain (Malde, 1959, 1965). Ray trace modelling of seismic data from the northwest margin of the eastern Snake River Plain (Sparlin et al., 1982) confirm this interpretation.

The predominant structural features in the Mt. Bennett Hills area are steeply dipping, dip-slip, normal faults (Smith, 1966). These fall into two roughly conjugate sets trending N40-70W and N70-90W. The faults dip

steeply; 75 to 90°. The northwest trending faults have the greater displacement; downward to the northwest. The normal faulting was active throughout Cenozoic time and greatly influenced the distribution of the volcanic units (Malde and Powers, 1972; Smith, 1966).

Thrust faulting and folding which characterize the ranges to the north are absent in the Mt. Bennett Hills. Folding is reported in the City of Rocks Tuff but it is probably a flow phenomenon (Smith, 1966).

2.5 Paleontology

The majority of the rocks in the Mt. Bennett Hills GRA are unfossiliferous. Beds of diatomite are reported in the Banbury Basalt and the Bruneau Formation (Malde and Powers, 1972). Fossil mammals, including Mammuthus, Gigantocamelus, Equus, Sangamona, and Odocoileous, occur in lake and stream sediments within the Bruneau Formation (Evernden et al., 1964; Malde and Powers, 1962). These fossils are important indices in North American mammalian chronology (Malde and Powers, 1972). The Bruneau Formation does not outcrop within any of the WSAs in the Mt. Bennett Hills GRA.

2.6 Historical Geology

The Cenozoic volcanic rocks which underly most of the Mt. Bennett Hills GRA were deposited over the Atlanta Lobe of the Idaho batholith (Taubeneck, 1971). K-Ar dates from the Idaho batholith indicate that the bulk of the pluton was emplaced 75 to 100 m.y. ago (McDowell and Kulp, 1969; Armstrong et al., 1977). Most K-Ar dates have been reset to the 50 to 40 m.y. range

(Armstrong et al., 1977, Hyndman et al., 1975) due to a regional metamorphic event (Williams, 1977) or by hydrothermal alteration associated with the emplacement of early Tertiary plutons during the Challis-Lowland Creek volcanic events (Bennett, 1980). The batholith was emplaced into basement orthogneiss and metamorphosed Precambrian sediments (Hyndman, 1978).

The Challis volcanics were erupted over a rugged elevated topography (Smith, 1966) from about 51 to 45 m.y. ago (Skipp, 1981). Minor volcanism and intrusive activity continued during this epoch until about 40 m.y. ago (Protska et al., 1977). Normal and strike-slip faulting preceeded and accompanied volcanism (Skipp, 1981). Many mineral deposits in the region formed above or adjacent to these Tertiary plutons (Bennett, 1980).

After a relatively tectonically inactive period during Oligocene (38-23 m.y.) and early Miocene (23-6 m.y.), major basin-and-range extension faulting commenced about 17 m.y. ago. Eastward tilting of the uplifted fault blocks along moderately dipping normal faults located on their west flank formed the narrow, linear north- to northwest-trending mountain ranges located to the north of the Mt. Bennett Hills GRA (Skipp, 1981). South of the GRA, the downwarp of the Snake River Plain began about 15 m.y. year ago (Armstrong et al., 1975, 1980).

Extensive silicic volcanism and extrusion of ignimbrite sheets onto a block-faulted topography by late Miocene or early Pliocene formed the Idavada Group (Smith, 1966; Malde and Powers, 1972). These rocks are broadly correlative with Miocene-Pliocene ash-flow shets buried under the Holocene Basalts in the eastern Snake River Plain (McBroome et al., 1981). The

Idavada volcanics were deposited in the latter stages of the dominantly silicic caldera volcanism which characterized the early development of the Snake River Plain (Protska, 1979).

Basaltic volcanism predominated beginning in the mid-Pliocene with deposition of the Banbury Basalt and the Glenns Ferry Formation. Block-faulting continued during this time with deposition of lake and stream sediments between volcanic episodes. Block-faulting largely terminated by the end of the Pliocene (Smith, 1966). Broad valley erosion and lake sedimentation with sporadic basaltic volcanism contined through the Pleistocene with deposition of the Bruneau Formation (Evernden et al., 1964). The area was gradually uplifted and erosion resulted in the deposition of pediment, talus and alluvial sediments during late Pleistocene and Holocene time (Malde and Powers, 1972).

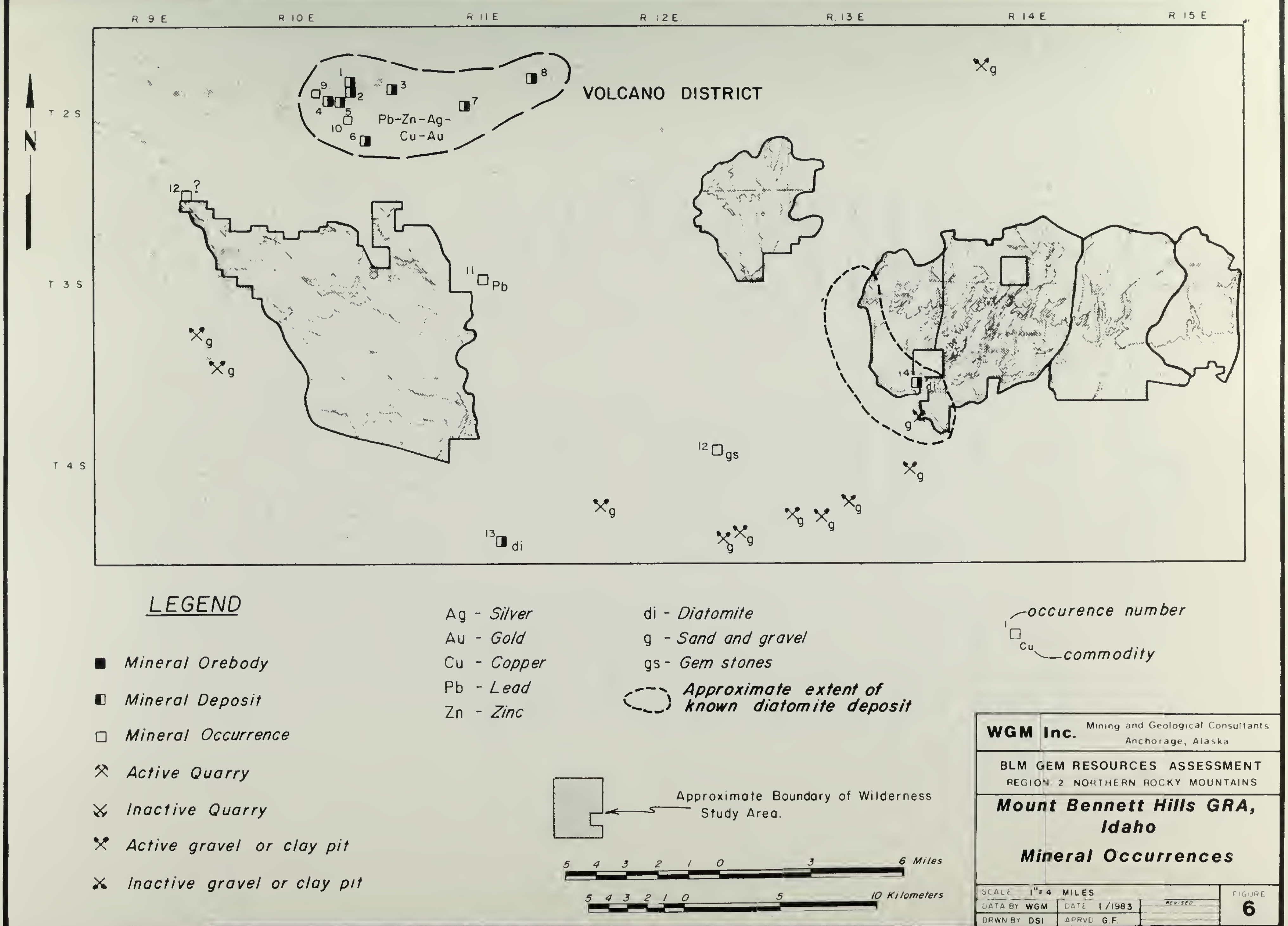
3.0 MINERAL AND ENERGY RESOURCES

3.1 Introduction

Data on the mineral and energy resources of the Mt. Bennett Hills GRA was compiled from all available sources. Information on mineral resource occurrences was obtained from the U.S. Geological Survey CRIB File, the U.S. Bureau of Mines MILS File, and Hustedde et al. (1981). Detailed descriptions of mineral deposits in the GRA include Allen (1940, 1952), Treco Industries Inc. (1974), and L. Dee (pers. comm., 1982). Energy resource data on the GRA includes Breckenridge (1982), Ross (1971), Mitchell et al. (1980), Sammel (1979), Arney (1982) and Moreland (1976). In addition, oil and gas well locations and data is kept on file at the Idaho Oil and Gas Conservation Commission. The U.S. Department of Energy has conducted a hydrogeochemical and stream sediment reconnaissance of the Hailey and Challis Quadrangles (U.S. Dept. of Energy, 1982). However only the basic data has been released and it is not in a form that could be used in this assessment.

3.2 Known Mineral and Energy Deposits

The only known metallic mineral deposits in the Mt. Bennett Hills GRA are in the Volcano district in the northwest part of the GRA (locs. 1-10, Fig. 6, Table I). These deposits are hosted by quartz monzonite belonging to the Idaho batholith. The batholith has been intruded by numerous aplite and granophyre dikes (Allen, 1940) which are probably Tertiary in age (Allen, 1952). There are at least 10 mines and prospects in the district (Fig. 7,



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REGION 2 NORTHERN ROCKY MOUNTAINS

Mount Bennett Hills GRA, Idaho

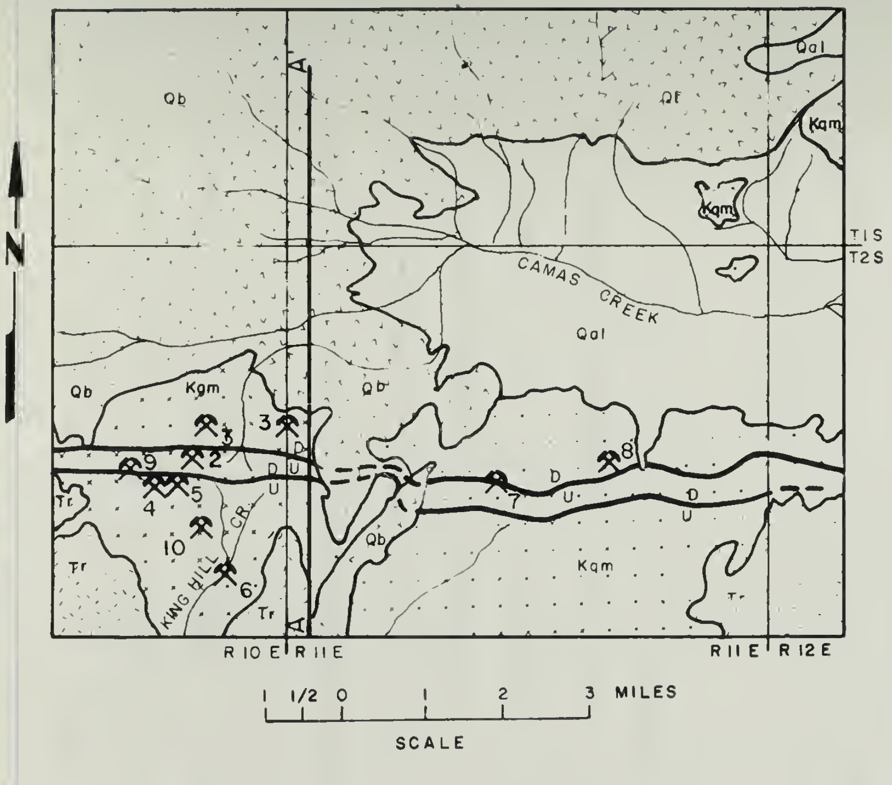
Mineral Occurrences

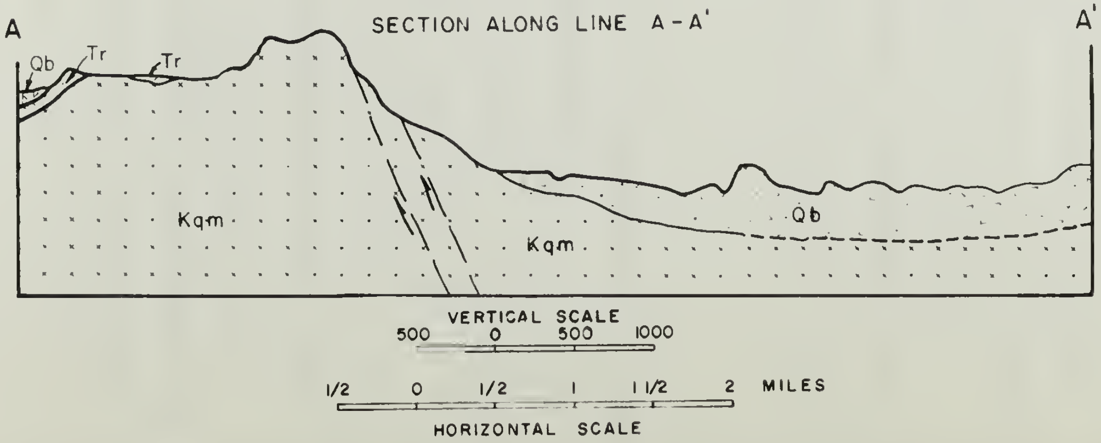
SCALE 1" = 4 MILES
DATA BY WGM
DATE 1/1983
DRWN BY DSI
APRVD G.F.
REVISED
FIGURE 6

TABLE I

MINERAL DEPOSITS AND OCCURRENCES IN THE MT. BENNETT HILLS GRA

Map No.	Name	Commodity	Reference
1	Old Glory Mine	Au-Ag-Pb-Zn-Cu	Allen (1940, 1952)
2	Jacobs Mine	Au-Ag-Pb-Zn-Cu	Allen (1940, 1952)
3	Volcano Mine	Au-Ag-Pb-Zn-Cu	Allen (1940, 1952)
4	Index Mine	Au-Ag-Pb-Zn-Cu	Allen (1940, 1952)
5	Holly Mine	Au-Ag-Pb-Zn-Cu	Allen (1940, 1952)
6	Ajax Mine	Au-Ag-Pb-Zn-Cu	Allen (1940, 1952)
7	Revenue Mine	Au-Ag-Pb-Zn-Cu	Allen (1940, 1952)
8	Bowerman Mine	Au-Ag-Pb-Zn-Cu	Allen (1940, 1952)
9	Unnamed	Au-Ag-Pb-Zn-Cu	Allen (1940, 1952)
10	Unnamed	Au-Ag-Pb-Zn-Cu	Allen (1940, 1952)
11	Clark	Pb	MILS (1982)
12	Unnamed	Gem opal	Williams (1964)
13	Unnamed	Diatomite	Powers (1947)
14	Clover Creek	Diatomite	Treco Industries Inc. (1974)




SECTION ALONG LINE A - A'

LEGEND

Qal	Alluvium
Qb	Basalt
Tr	Rhyolite
Kqm	Quartz Monzonite
D/U	Fault
⚒	Mine

MINES

1. Old Glory
2. Jacobs
3. Volcano
4. Index
5. Holly
6. Ajax
7. Revenue
8. Bowerman
9. Unnamed
10. Unnamed

Data from: Allen (1940, 1952)

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REGION 2 NORTHERN ROCKY MOUNTAINS

Mt. Bennet Hills GRA, Idaho

Geologic Map and Section of the Volcano Mining District

SCALE AS SHOWN			FIGURE
DATA BY	DATE 3/1983	REVISED	7
DRWN BY DSI	APRVL G.F.		

Table I). The deposits consist of networks of small quartz veins and stringers along complex fracture zones cutting quartz monzonite, aplite and granophyre. Individual mineralized veins average three to six inches in width and frequently occur in parallel groups enclosed in altered wallrock. The veins generally do not exceed 100 feet in length. The largest deposit mined was the Revenue vein which was eight to fifteen feet wide and 1,000 feet long. The veins consist of quartz with lesser calcite and contain small amounts of galena, sphalerite, chalcopyrite and pyrite. The deposits were mined for gold, but production figures are unknown. The gold occurs as microscopic granules and veinlets in quartz combs and druses. The vein systems trend N70E and dip 55 to 90° to the north parallel to the two major faults which cut the district (Allen, 1940). Sericite-quartz-epidote hydrothermal alteration is irreguarly developed within and adjacent to the shear-vein systems. Silicification is often present adjacent to individual veins (Allen, 1952).

Extensive deposits of diatomite are present in the east-central part of the Mt. Bennett Hills GRA including part of the Gooding WSA (loc. 14, Fig. 6). This deposit, the Clover Creek deposit, has been evaluated in recent years by private industry (TRECO Industries, Inc., 1974; L. Dee pers. comm., 1982). No description of the deposits or sample data are available. The deposits are underlain by the Banbury Basalt as mapped by Malde and Powers (1972) and Smith (1966). It is likely that the diatomite occurs in the sedimentary portion of the Banbury. Diatomite reserves in the deposits are estimated to be at least 680 million dry short tons with an additional 376 million dry short tons classed as probable reserves. Potentially an additional 438 million dry short tons is also present. Another diatomite

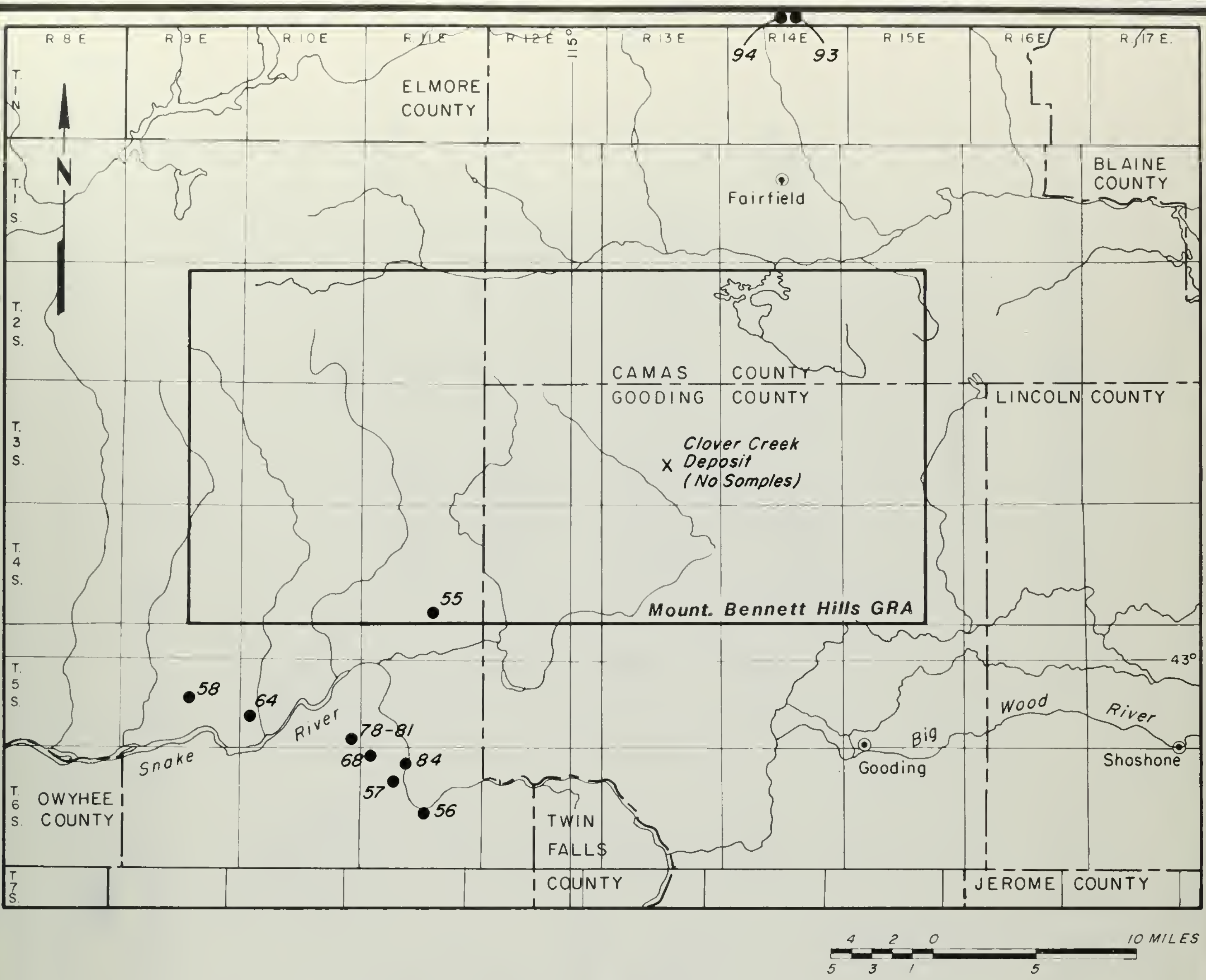
deposit (loc. 13, Fig. 6, Table I) is located near the southern boundary of the GRA in an area underlain by the Banbury Basalt. The deposit consists of a two-foot thick bed of diatomite and interbedded sediments between basalt flows. Reportedly, the deposit was mined in 1936 (Powers, 1947).

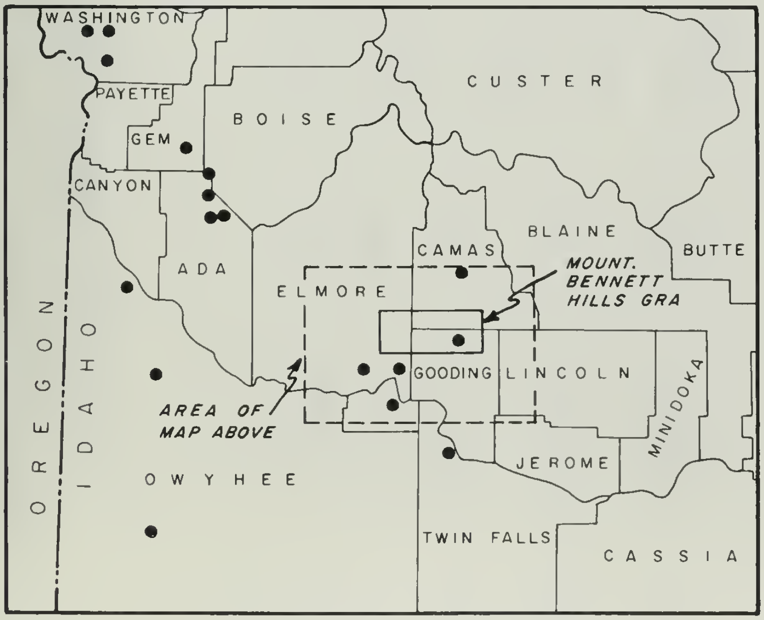
A number of diatomite deposits in the region (Fig. 8) were sampled by Powers (1947) whose data is summarized in Table II. Powers concluded that most of the deposits with low proportions of impurities are suitable for normal commercial uses, e.g. as insulation, absorbants, fillers, and concrete admixtures. Skinner et al. (1944) evaluated the filter characteristics of three of these deposits including the one at locality 13 (Fig. 6) and concluded that they were of low value as filter media which is the highest value use of diatomite (Kadey, 1975). The diatomite at locality 13, however does have excellent filler and absorbant characteristics (Sample No. 55, Fig. 8, Table II). No data on diatomite quality is available from the Clover Creek deposit.

3.3 Known Mineral and Energy Prospects, Occurrences, and Mineralized Areas

There are two other mineral occurrences in the Mt. Bennett Hills GRA in addition to the deposits described in the previous section. These are a lead occurrence (loc. 11, Fig. 6, Table I) located just east of WSA 19-2 (MILS, 1982), and a gem opal occurrence (loc. 12, Fig. 6, Table I). No description of either occurrence is available.

The only known energy prospects or occurrences in the Mt. Benett Hills GRA are hot springs and thermal wells, both of which are abundant along the





Index Map of Diatomite Deposits

Data from: Powers (1947).

●55 Diatomite Sample Locality with Sample Number

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REGION 2 NORTHERN ROCKY MOUNTAINS

Mount. Bennett Hills GRA, Idaho

Location of Diatomite Samples

SCALE 1:500,000			FIGURE
DATA BY	DATE 3/1983	REVISED	8
DRWN BY DSI	APRVD G F		

TABLE II

PROPERTIES OF DIATOMITE SAMPLES IN THE VICINITY OF THE MT. BENNETT HILLS GRA, IDAHO

Sample No.	Predominant Diatom	Color	Impurities	Block Density (lb/ft.^{3})	Powder Density (lb/ft.^{3})	Remarks
93	Melosira	White	Small amount quartz, clay	31.8	14.4	Good for all normal uses, low filter media value.
94	Melosira	White	Small amount quartz, clay	26.8	11.2	Good for all normal uses, low filter media value.
58	Epithemia	White	Considerable quartz, muscovite	----	----	Too impure for commercial use.
64	Stephanodiscus	White to Ivory	Small amount, organic, quartz, biotite, clay	53.1	21.8	Unsatisfactory for fillers and absorbants, satisfactory for concrete admixture and polish if grit removed.
55	Fragilaria	White	Very pure	32.4	11.9	Excellent filler or absorbant, good polishing medium, low filter media quality.
57,68, 78	Stephanodiscus	Tan	20% quartz, clay	----	----	Not of commercial value.
56,80, 81,84	Melosira, Stephanodiscus	Cream White	25% quartz, clay, muscovite	----	----	Not of commercial value.
66	Stephanodiscus	-----	10% clay, minor quartz, calcite	-----	----	Fair for all normal uses except filter media.

Data from Skinner et al. (1944) and Powers (1947).

edges of the Mt. Bennett Hills. Surface temperatures from six thermal springs and two warm water wells in the GRA (Table III, Fig. 9) range from 27° to 65°C. The aquifers for most of these occurrences are in Pliocene basalts. Analyzed waters from White Arrow Hot Springs (loc. 6, Table III, Fig. 9) and Latty Hot Springs (loc. 8, Table III, Fig. 9) yielded silica-geothermometer values of 135°C and 137°C, respectively. For wells in the vicinity of the Mt. Bennett Hills GRA and located outside of the Snake Plain Aquifer, the geothermal gradients range from 51° to 181°C/km, (2.8° to 9.9°F/100 ft.) and heat flow values range from 1.7 to 10.0 cal/cm^2 sec. (Table IV). These values are well above average which is typical for the margin of the Snake River Plain. Several of the thermal springs and wells in the GRA are used for space heating and other domestic uses.

3.4 Mining Claims, Leases and Material Sites

A review of BLM claims records current to June 7, 1982 show a total of 98 unpatented mining claims in the Mt. Bennett Hills GRA (Fig. 10). The claims are concentrated in two areas: (1) forty-six claims in the Volcano mining district, and (2) fifty-two claims covering diatomite deposits located in the east-central part of the GRA (L. Dee pers. comm., 1983). Parts of this claim block are within the Gooding and City of Rocks WSAs.

About 10% of the Mt. Bennett Hills GRA is covered by oil and gas leases (Fig. 11). These leases are in the southeast quadrant of the GRA and six leases overlap the King Hill Creek WSA (Table IV).

TABLE III

OCCURRENCES OF THERMAL WATER IN THE MT. BENNETT HILLS GRA, IDAHO

Map No.	Name	Location			Type (Depth m.)		Discharge L/M	Surface Temp (°C)	Estimated Aquifer Temp (°C)	Aquifer Age & Rock Type	Reference
		Sec.	T.	R.							
1	Mormon Reservior	17	2S	14E	Spring	---	Below reservoir	--	---		Mitchell et al. (1980)
2	Tschanne Hot Spring	35	4S	12E	Spring	---	Dry (1980)	43	43	Pliocene basalt.	Ross (1971)
3	Dave Archer Well No. 1	35	5S	12E	Well	211	----	57	---	Pliocene basalt and sediments.	Ross (1971), Stearns et al. (1938)
4	J. Shannon Well	28	4S	13E	Well	49	----	47	---	Pleistocene basalt.	Stearns et al. (1938)
5	Hot Sulphur Lake	29	4S	13E	Spring	---	Below lake	27	---	Quaternary basalt.	Ross (1971)
6	White Arrow	30	4S	13E	Spring	---	126	65	108	Quaternary alluvium.	Malde et al. (1963)
7	Coyote	25	3S	9E	Spring	---	283	57	---	Pliocene silicic volcanic rocks.	Mitchell et al. (1980)
8	Latty	31	3S	10E	Spring	---	100	62	137	Pliocene silicic volcanic rocks.	Mitchell et al. (1980)

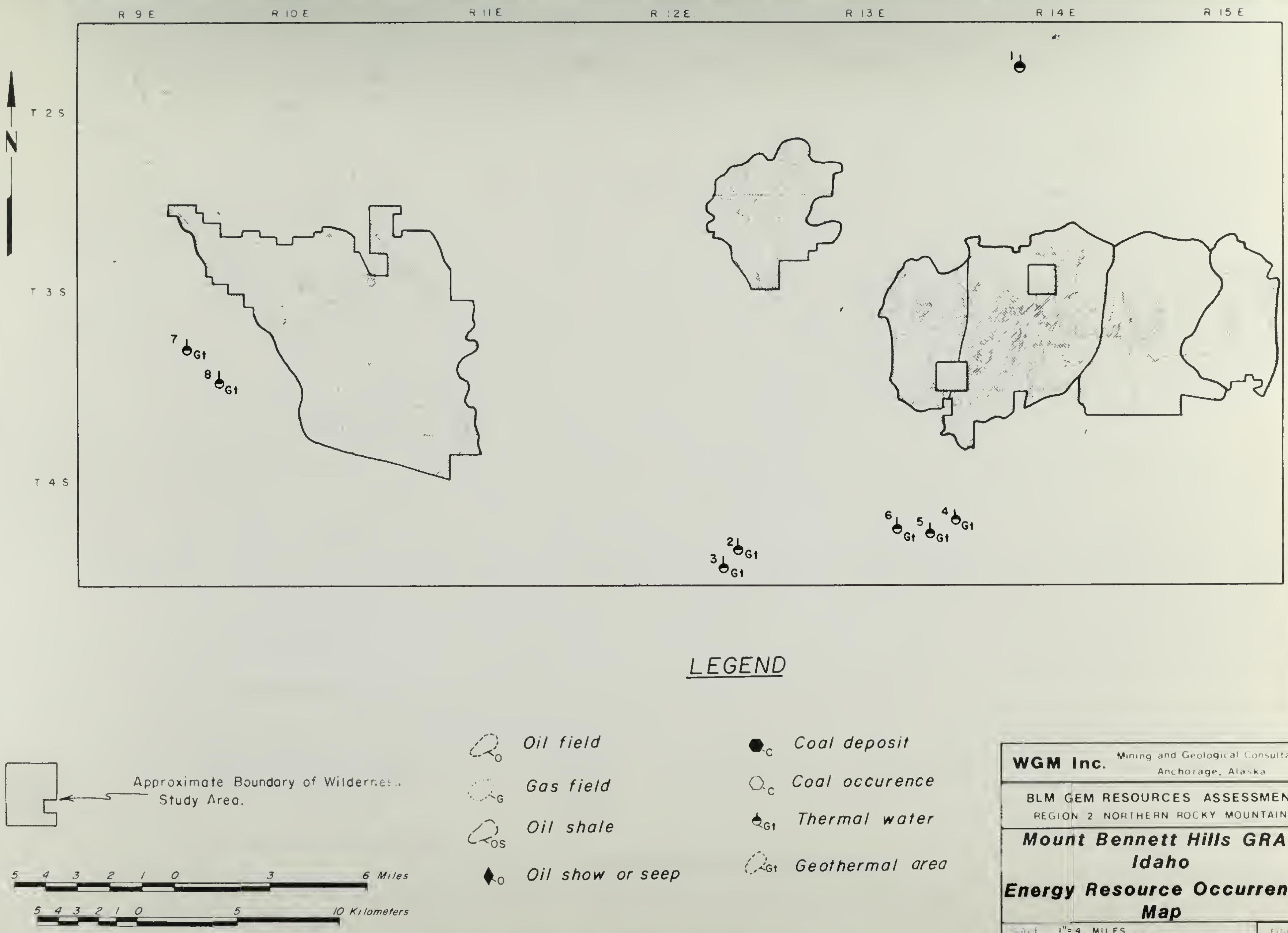
Data from Young and Mitchell (1973) and Mitchell et al. (1980).

TABLE IV

HEAT FLOW DATA IN THE VICINITY OF THE MT. BENNETT HILLS GRA

Location			Collar	Depth	Collected	Corrected Heat Flow
Sec.	T.	R.	Elev. (meters)	Interval (meters)	Gradient (°C/km)	(10^{-6} cal/cm sec.)
23	1S	9E	1561	95-150	46.7	2.95
13	1S	12E	1551	15- 65	89.1 2.3	2.92
7	1S	13E	1551	10- 60	72.9 4.0	2.41
21	1S	13E	1544	15- 47	66.1 6.8	2.17
20	1S	14E	1536	10- 55	181.4 3.4	9.98
21	2S	14E	1609	10- 90	51.4 2.0	1.67
30	4S	10E	1051	100-410	98.8 1.9	3.27
26	5S	12E	1019	15- 30	50.0 1.2	1.84
6	5S	15E	1109	45-104	61.8 0.5	3.02
17	5S	15E	1103	38- 63	16.0 2.7	0.53*
34	5S	15E	1105	8- 54	44.5 5.7	2.01*

Data from Brott et al. (1976, 1981) and Blackwell (unpublished).
* In Snake River Aquifer.



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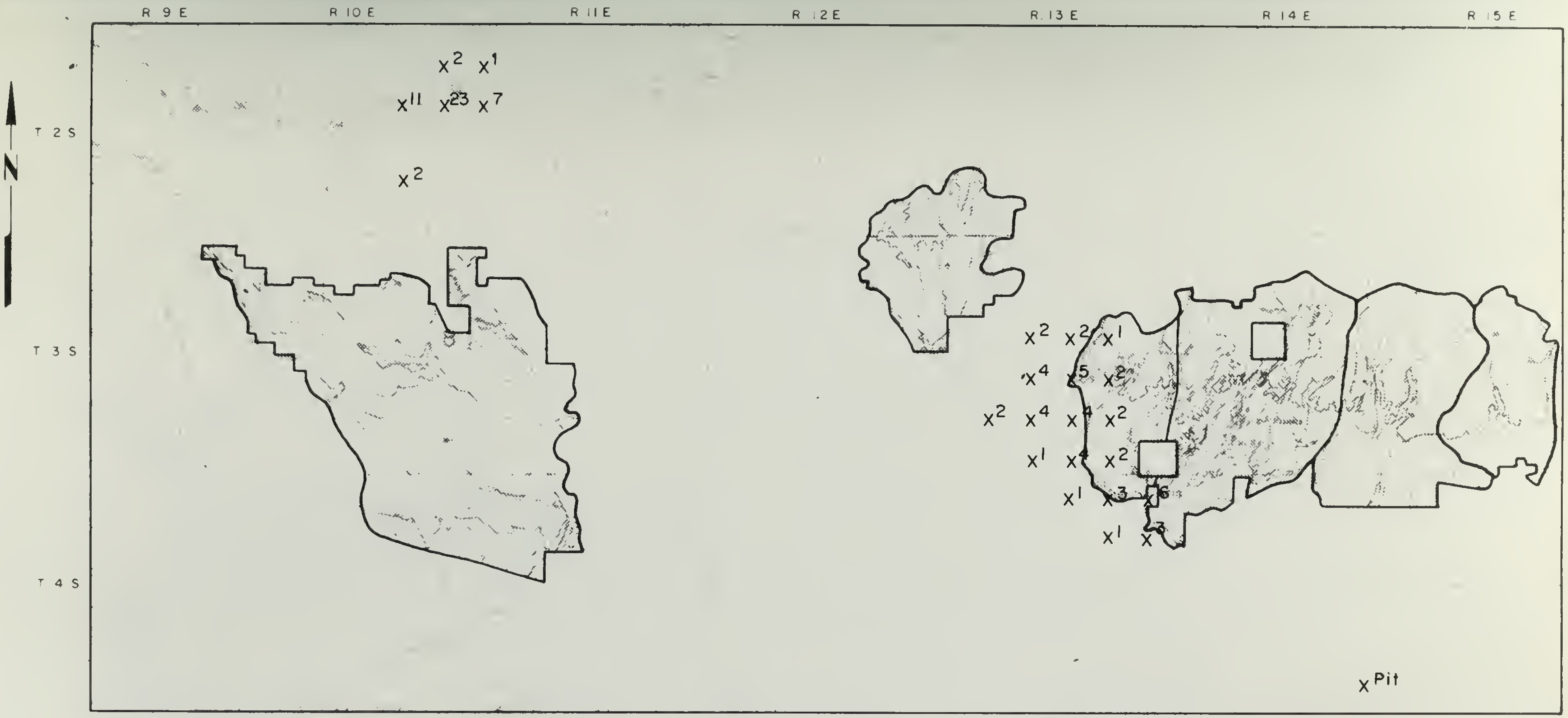
Mount Bennett Hills GRA, Idaho

Energy Resource Occurrence Map

SCALE 1" = 4 MILES		FIGURE
DATA BY NGM	DATE 3/1983	REV SED
DRWN BY DSI	APPVL G F	9



EXPLANATION

X Unpatented Mining Claim

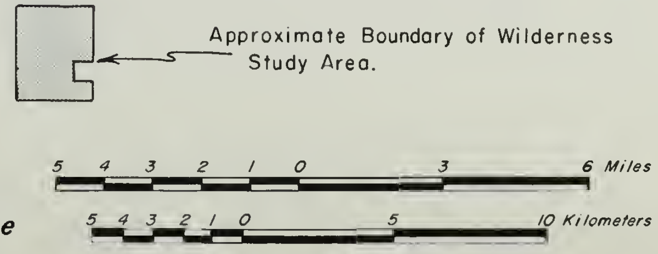
▲ Patented Mining Claim

Notes: 1) Number adjacent to symbol indicates number of mining claims in that section.

2) Area of search: Entire GRA

3) Source of Data: BLM Claims Microfiche

4) Data current to: June 7, 1982


Approximate Boundary of Wilderness Study Area.
5 4 3 2 1 0 3 6 Miles
5 4 3 2 1 0 5 10 Kilometers

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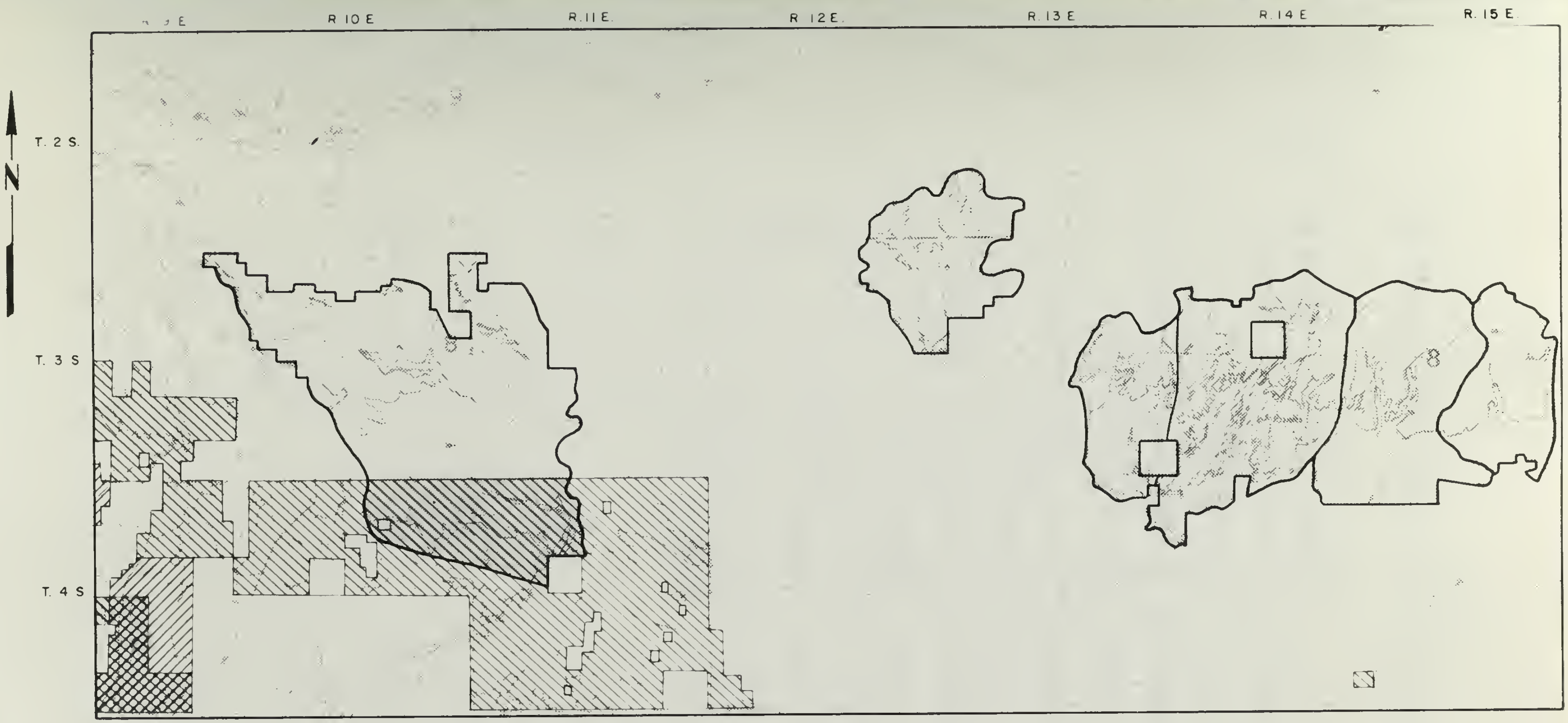
REGION 2 NORTHERN ROCKY MOUNTAINS

Mount Bennett Hills GRA, Idaho

Mining Claims Density Map

SCALE 1"=4 MILES			FIGURE
DATA BY WGM	DATE 1/1983	REV SEC	10
DRWN BY DSI	APRVD G.F.		



LEGEND

▧ Area covered by oil and gas leases.

▨ Area covered by geothermal lease.

Approximote Boundary of Wilderness Study Area.

Notes: 1) Area of Search: Entire GRA
2) Data current to: Aug. 12, 1982
3) Source of Data: BLM Oil and Gas Plats

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BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Mount Bennett Hills GRA, Idaho

Energy Lease Status

SCALE			FIGURE
DATA BY	DATE 9·83	REVISED	11
DRWN BY	APRVD		

TABLE V

OIL AND GAS LEASES IN WSAs IN THE MT. BENNETT HILLS GRA, IDAHO

WSA	Lease No.	Owner of Record	Date Issued
19-2	I 6800	Cities Service Oil Company Box 300 Tulsa, Oklahoma 74102	11-01-74
	I 6801	Cities Service Oil Company Box 300 Tulsa, Oklahoma 74102	10-01-75
	I 6802	Cities Service Oil Company Box 300 Tulsa, Oklahoma 74102	10-01-75
	I 6804	Cities Service Oil Company Box 300 Tulsa, Oklahoma 74102	11-01-73
	I 6805	Cities Service Oil Company Box 300 Tulsa, Oklahoma 74102	11-01-73
	I 6808	Cities Service Oil Company Box 300 Tulsa, Oklahoma 74102	03-01-74

There are also geothermal leases in the southeast part of GRA but none overlap the WSAs (Fig. 11).

3.5 Mineral and Energy Deposit Types

The rocks underlying most of the Mt. Bennett Hills GRA are mafic to acidic volcanics and associated sediments of Eocene to Pleistocene age (Fig. 4). These volcanics were extruded over terrane underlain by the Idaho batholith which was emplaced 75-100 m.y. ago (Armstrong et al., 1977). The batholithic rocks, only locally exposed, are generally covered by a thick volcanic sequence exceeding several thousand feet in thickness. Metallic mineral deposits which can be expected in the above setting are those related to: (1) magmatic emplacement, and (2) volcanic extrusion.

The Volcano district is typical of mineralization related to magmatic emplacement. The gold-base metal veins and lodes of this district are localized along an east-trending shear zone in quartz monzonite belonging to the Idaho batholith. The ore appears to be associated with granophyric dikes which intrude the main batholith. These dikes are probably related to a later Tertiary intrusive event rather than the intrusion of the Idaho batholith. Potential for this type of mineralization certainly exists elsewhere in the Mt. Bennett Hills GRA, but no data is available in areas where the batholithic terrane is masked by overlying volcanics.

As discussed in Section 2.6, the Idavada volcanics were deposited during the latter stages of the dominately silicic volcanism which characterized the early development of the Snake River Plain whereas the Idaho Group is more

typical of the early stages of basaltic volcanism characteristic of later development of the Snake River Plain. The absence of regional detailed geologic mapping, geochemical data, or known metallic mineral occurrences in areas underlain by these rocks makes evaluation of their mineral potential difficult. The mineral potential of these rocks must be evaluated by comparison of the tectonic setting and geologic processes active in the Mt. Bennett Hills region to those of similar mineralized areas. The gross tectonic setting of the volcanics within the Mt. Bennett Hills GRA consists of three geologic environments: (1) rhyolitic calderas, (2) felsic plugs, and (3) subareal basalt flows.

The continuing sequence of extrusion, block faulting and sedimentation evident in the Tertiary rocks underlying the Mt. Bennett Hills GRA resembles the resurgent calderas described by Smith and Bailey (1968). Mineralization of several types, including precious metal-rich veins (Lipman et al., 1976) and massive sulfide deposits (Hodgson and Lyden, 1977) are associated with caldera systems. Descriptions of the acid volcanic rocks within the GRA (Smith, 1966) indicate that some hydrothermal activity is associated with the silicic volcanics, but no associated mineralization is reported.

Although there are no known subvolcanic intrusives in the Mt. Bennett Hills GRA, the tectonic setting is favorable and more detailed mapping might reveal some. In a recent review of the relationship of mineral deposits and tectonic settings, Mitchell and Garson (1981) suggest that mineral deposits in rifted continental settings such as the Snake River Plain are predominately deposits of tin, uranium and molybdenum related to alkaline

intrusives and peraluminous granites. A hydrogeochemical and stream sediment geochemical sampling program for uranium was conducted in the Hailey and Challis NTMS Quadrangles, including the Mt. Bennett Hills GRA, to evaluate the uranium potential of the area (U.S. Dept. of Energy, 1982). Only the basic data from this program; analytical results without sample location maps, have been released. As a result, the data could not be used in this study. Recent exploration by Amax, Inc. at Big Southern Butte, a rhyolitic dome in the eastern Snake River Plain some 90 miles west of the Mt. Bennett Hills GRA, resulted in the discovery of molybdenum stockwork mineralization in the subsurface (S. Hamilton pers. comm., 1982). Similar potential would exist in the Mt. Bennett Hills GRA if any subvolcanic intrusives are present.

Diatomite is a rock composed of microscopic porous shells of silica, the remains of a single-celled aquatic organism. The principal domestic use of diatomite is as a filtering material in water purification, food processing and industrial fluids. Other uses include fillers, mild abrasives and construction and insulating materials. Economic diatomite deposits belong to three classes: (1) marine rocks that accumulated near continental margins, (2) non-marine rocks that formed in lakes or marshes, and (3) sediments in present-day lakes, marshes and bogs. The diatomite deposits in the Banbury basalt and Bruneau Formation were deposited in lakes; thus the deposits belong to the second class of deposits. Diatomite deposits can be prospected by geologic mapping of favorable stratigraphic sequences. After, diatomite is found in outcrop, the size of the deposit is determined by trenching or drilling. The quality of diatomite in a deposit may vary considerably from bed to bed; thus, careful sampling throughout its

thickness is necessary to establish quality and potential use of the material. As with most industrial minerals, the location of a diatomite deposit with respect to market is probably the most important economic factor in the viability of a deposit (Durham, 1973).

The Mt. Bennett Hills GRA lies along the western border of the Eastern Snake River Plain mostly within the eastern part of the Western Snake River Plain. Forty-three hydrocarbon tests have been drilled in the Western Snake River Plain since 1907 (Breckenridge, 1982). Most were drilled northwest of Boise and only five penetrated to depths greater than 5,000 feet. Several tests have reported oil or gas shows, but they were all plugged and abandoned as dry holes.

Insufficient tests have been drilled in the Western Snake River Plain to classify it as a non-petroleum province, but prospects are not encouraging. Hydrocarbon test wells have penetrated to depths of 11,125 feet (Breckenridge, 1982) in the Western Snake River Plain, but none of them have penetrated below Cenozoic strata. A test drilled approximately three miles west of the southwestern corner of the Mt. Bennett Hills GRA was in a sequence of tufa, clays and basalt at 8,500 to 9,000 feet (Idaho Oil and Gas Conservation Commission Well Log for Bostic 1-A dry hole). The Mt. Bennett Hills GRA lies west of the Thrust belt, in a region where the Idaho batholith dips beneath the volcanics (Taubeneck, 1971); thus, it is unlikely that the structures or stratigraphy of the Thrust belt region are present beneath the GRA.

The presence of lake beds within the tufa and basalt flows reported in the Bostic 1-A test could be potential hydrocarbon source beds and potential reservoir beds might occur in fractured or vuggy basalt beds or the few sandstones in the sequence (Idaho Oil and Gas Conservation Commission Well Log for Bostic 1-A dry hole). Unfortunately, hydrocarbon characterization and thermal maturation studies were apparently not made on samples from the Bostic 1-A test. The presence of several volcanic vents in the GRA, however, decreases considerably any hydrocarbon potential within the Mt. Bennett Hills GRA. The extent of the metamorphism surrounding the vents and depth to the magmatic masses that the vents were derived from are unknown. The position of the magmatic masses can be determined by geophysical studies, but the extent of the metamorphism can only be determined by drilling.

In the most recent geothermal classification of the United States (Muffler, 1979), geothermal resources were divided into six categories. These are:

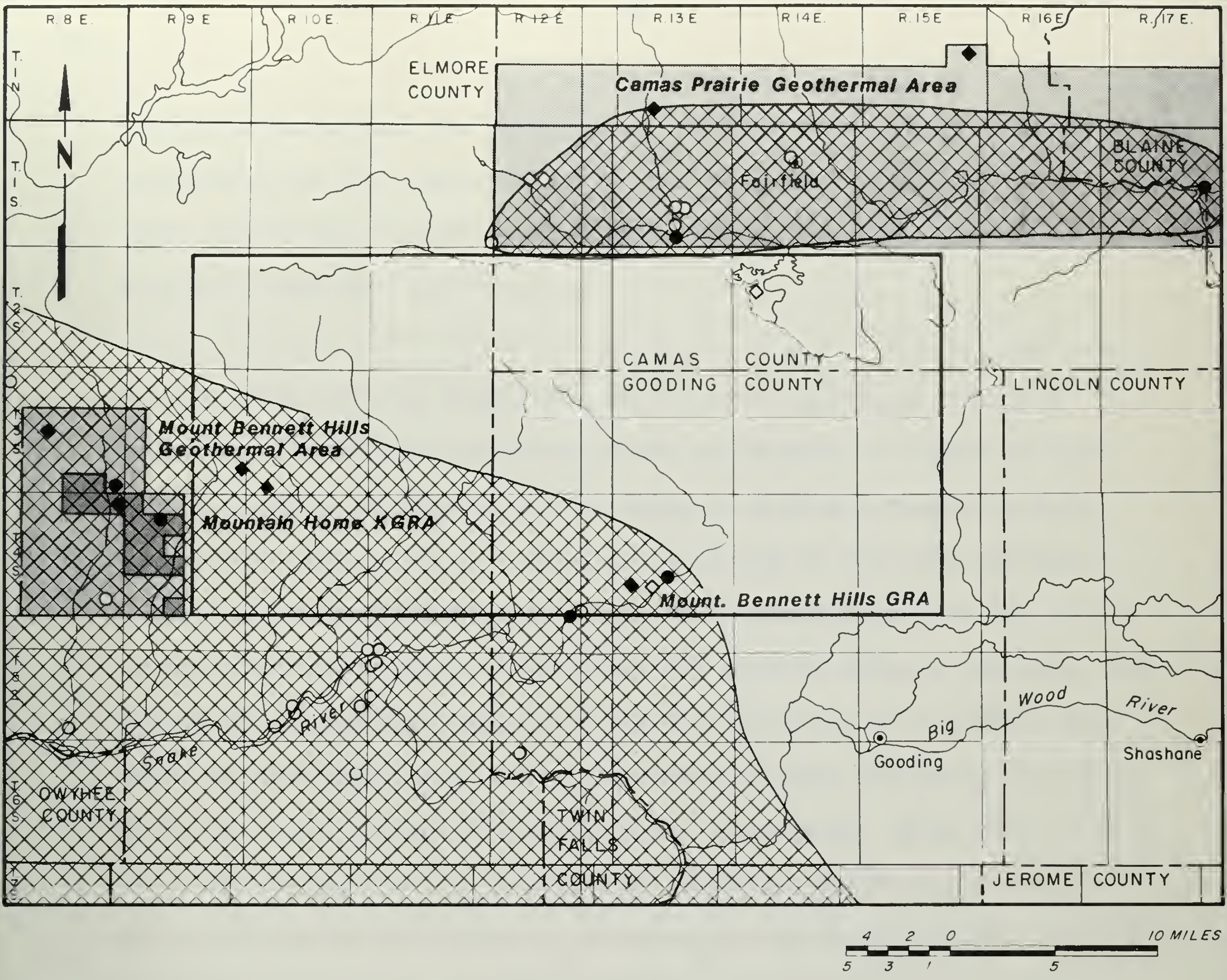
1. Conduction-dominated regions
2. Igneous-related geothermal systems
3a. High temperature (over 150°C) hydrothermal convection systems
 b. Intermediate temperature (90-150°C) hydrothermal convection systems
4. Low temperature (less than 90°C) hydrothermal convection systems
5. Geo-pressured geothermal energy systems

For the purposes of this Wilderness Study Area assessment these classes can be reduced to two: (1) high temperature (over 150°C) hydrotheral convection systems and (2) low/intermediate temperature (40-150°C) hydrothermal

convection systems. Geo-pressured geothermal energy systems do not exist in the areas discussed. Theoretically geothermal resources exist everywhere because the temperature of the earth's crust everywhere increases with depth; thus, high temperatures are reached at some depth below any given point on the earth's surface. At the present time, and in the foreseeable future, a naturally occurring hot fluid coupled with sufficiently porous and permeable rocks to allow fluid migration are necessary prerequisites for practical use of geothermal energy; thus, conduction-dominated and "magma-tap" geothermal systems are not included in this evaluation.

The Mt. Bennett Hills GRA is in the Snake River Plain geothermal province, an area of major volcanic and tectonic activity, which has major geothermal potential. The Snake River Plain is a large graben or downwarp where the surface rhyolitic rocks underlying the Mt. Bennett Hills are buried farther south by 7,000 feet of younger basalts and sedimentary rocks (Mabey, 1976). The Mt. Bennett Hills area is extensively broken by faults which cut all but the youngest rock units. Most of the exposed faults trend northwest, but major east-west faults with large displacement may be buried along both the north and south margins of the Mt. Bennett Hills. At the present time, the Mt. Bennett Hills area does not appear to be seismically active.

Investigations by the Idaho Department of Water Resources (Mitchell, 1976; Mitchell et al., 1980) have identified two geothermal resource areas immediately adjacent to the Mt. Bennett Hills GRA (Fig. 12): (1) Mt. Bennett Hills on the west, and (2) Camas Prairie, an east-west fault-bounded basin, on the north. The Mt. Bennett Hills geothermal resource area includes all of the Mountain Home Known Geothermal Resources Area (KGRA)



LEGEND

▩	Known Geothermal Resources Area - (KGRA), U.S. Geological Survey Designation.
▨	Geothermal Resource Area - Idaho Dept. of Water Resources Designation.
▦	Area Favorable for the Discovery and Development of Low Temperature (90°C.) Geothermal Resources (Sammel, 1979).

Thermal Springs, Generally ≥ 20°C.

- ◆ Surface Temperature ≤ 50°C.
- ◇ Surface Temperature > 50°C.

Thermal Wells, Generally ≥ 20°C.

- ● Surface Temperature ≤ 50°C.
- ○ Surface Temperature > 50°C.

Data from: Mitchell, et.al. (1980).

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Anchorage, Alaska

BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Mount. Bennett Hills GRA, Idaho

Regional Geothermal Setting

SCALE 1:500,000			FIGURE
DATA BY WGM	DATE 3/1983	REVISED	**12**
DRWN BY DSI	APRVD G F.		

delineated by the U.S. Geological Survey (Sammel, 1979). Areas considered prospective for low temperature goethermal resources include most of the Camas Prairie and the Western Snake River Plains (Fig. 12). Most of the King Hill Creek WSA is in the latter area.

A hydrocarbon test, the Bostic 1-A, drilled in the Mountain Home KGRA encountered interbedded sedimentary rocks and basalts to a depth of 7,150 feet followed by interbedded silicic volcanic rocks and basalts to 9,767 feet (total depth). The silicic volcanic section in this hole has been downwarped or downfaulted several thousand feet with respect to the silicic volcanic section in the King Hill Creek WSA about 10 miles to the east. The bottom hole temperature measured in the Bostic 1-A was 371°F (189°C) at a depth of 8,898 feet; thus, the mean gradient is about 66°C/km (3.6°F/100 ft.). No significant fluid production was encountered. Arney et al. (1981) evaluated the area for its Hot Dry Rock geothermal potential and rated it highly. Arney (1982) studied the mineralogy of the silicic rocks and noted evidence for at least one episode of high temperature (200°C) fluid flow within the rock; therefore, an electrical grade geothermal resource had existed at some time in the past.

Artesian wells are common along the margins of the Mt. Bennett Hills (Walton, 1972), but the hydrology of the Mt. Bennett Hills is known only from a few springs. Ground water probably flows downslope toward the Camas Prairie to the north and the Snake River Plains to the south. Unwelded tuffs, and joint systems in the welded silicic tuffs, are probably the major shallow aquifers. The many large displacement faults may be conduits for deep circulation. The high regional heat flow and geothermal gradients

along with the widespread occurrence of thermal springs and wells are clear indications of geothermal resources. Thus each WSA must be carefully evaluated. Without direct evidence, this evaluation must be preliminary. Because of the topographic pressures on ground water flow, the most favorable location of hydrothermal systems will be along the south ends of the Little City of Rocks, Black Canyon, Gooding and City of Rocks WSA. Unless the heat has been flushed deeper down gradient by rapid water flow, those parts of the WSAs almost definitely have low/moderate geothermal resource potential and they might have high temperature geothermal resource potential. The higher elevations and probable thin young silicic volcanic section suggest that the potential is lower in the Deer Creek WSA. The well closest to the north end of the WSA has the lowest heat flow (1.7 cal/cm^2 sec.) and one of the lowest gradients. Although one hole is certainly not definitive this suggests possible downslope transfer of heat. The proximity of the King Hill Creek WSA to areas of demonstrated low/moderate and possible high temperature geothermal resources is clearly shown and there is every geologic reason to expect that these resources exist within the WSA as well.

3.6 Mineral and Energy Economics

At present, the best mineral and energy exploration potential in the Mt. Bennett Hills GRA is for gold, diatomite, and geothermal energy.

The large gold price increases in recent years have led to a re-examination of many gold mining districts and the reopening of formerly uneconomic mines (Butterman, 1980). This interest has extended into Idaho (Bennett et al.,

1982) as indicated by the active claims in the Volcano district. The easy access to the district and ample water sources in nearby reservoirs make even small deposits economically attractive.

Over 680,000 tons of diatomite were produced in the United States in 1981 from mines in California, Nevada, Oregon and Washington (Meisinger, 1982). Domestic consumption of diatomite in 1981 was 525,000 tons. Diatomite is one of the few mineral commodities which the United States exports. It contributed an estimated $33 million to our export trade in 1981. The price of diatomite depends on its use with filter grade diatomite being the highest value use. The value of diatomite in 1981 ranged from $110/ton for absorbant and abrasive grades to $179/ton for filter grade material. Like all industrial minerals diatomite is sensitive to transportation costs. Careful and relatively expensive technical evaluation as well as thorough market research is required to determine the economic feasibility of a diatomite deposit (Kadey, 1975).

Based on present requirements for use of hot fluids in electrical generating techniques, geothermal systems with temperatures of less than 150°C do not have significant potential for electrical exploitation. These systems, however, can have a significant potential for low and intermediate temperature geothermal utilization for space heating, material processing, etc. if their minimum temperatur exceeds 40°C. At the lower end of the spectrum, as the energy content of the resource becomes less, or the drilling depth necessary for exploitation becomes greater, there is a very ill-defined cutoff. For example, shallow ground water temperatures on the order of 10-20°C can be used for heat pump applications, and in some cases these are

considered geothermal resources. However, for the purpose of this evaluation, a lower temperature than approximately 40°C is considered an economic cutoff for a geothermal resource. Another important economic factor affecting the viability of a geothermal resource is the distance from the source to the point of consumption. At lower temperatures it is not feasible to consider long-distance transportation of geothermal energy whereas for electrical grade resources long transportation distances are of course feasible. The presence of developments within and adjacent to the Mt. Bennett Hills GRA would ensure that geothermal resources, even low temperature ones, would be exploited.

4.0 LAND CLASSIFICATION FOR GEM RESOURCES POTENTIAL

4.1 Explanation of Classification Scheme

In the following sections the land in the Mt. Bennett Hills GRA is classified for geology, energy and mineral (GEM) resources potential. The classification scheme used is shown in Table VI. Use of this scheme is specified in the contract under which WGM prepared this report.

The evaluation of resource potential and integration into the BLM classification system has been done using a combination of simple subjective and complex subjective approaches (Singer and Mosier, 1981) to regional resource assessment. The simple subjective approach involves the evaluation of resources based on the experience and knowledge of the individuals conducting the evaluations. The complex subjective method involves use of rules, i.e. geologic inference, based on expert opinion concerning the nature and importance of geologic relationships associated with mineral and energy deposits (Singer and Mosier, 1981).

The GEM evaluation is the culmination of a series of tasks. The nature and order of the tasks was specified by the BLM, however they constitute the general approach by which most resource evaluations of this type are conducted. The sequence of work was: (1) data collection, (2) compilation, (3) evaluation, and (4) report preparation. No field work was done in the Mt. Bennett Hills GRA.

TABLE VI

BUREAU OF LAND MANAGEMENT GEM RESOURCES LAND CLASSIFICATION SYSTEM

CLASSIFICATION SCHEME

1. The geologic environment and the inferred geologic processes do not indicate favorability for accumulation of mineral resources.
2. The geologic environment and the inferred geologic processes indicate low favorability for accumulation of mineral resources.
3. The geologic environment, the inferred geologic processes, and the reported mineral occurrences indicate moderate favorability for accumulation of mineral resources.
4. The geologic environment, the inferred geologic processes, the reported mineral occurrences, and the known mines or deposits indicate high favorability for accumulation of mineral resources.

LEVELS OF CONFIDENCE

A. The available data are either insufficient and/or cannot be considered as direct evidence to support or refute the possible existence of mineral resources within the respective area.

B. The available data provide indirect evidence to support or refute the possible existence of mineral resources.

C. The available data provide direct evidence, but are quantitatively minimal to support or refute the possible existence of mineral resources.

D. The available data provide abundant direct and indirect evidence to support or refute the possible existence of mineral resources.

Mount Bennett Hills GRA, Idaho
Legend For Figure 13

BLM LAND CLASSIFICATION SYSTEM FOR GEM RESOURCES

CLASSIFICATION SCHEME

1. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES DO NOT INDICATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
2. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES INDICATE LOW FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
3. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, AND THE REPORTED MINERAL OCCURRENCES INDICATE MODERATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
4. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, THE REPORTED MINERAL OCCURRENCES, AND THE KNOWN MINES OR DEPOSITS INDICATE HIGH FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

LEVELS OF CONFIDENCE

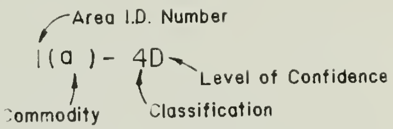
A. THE AVAILABLE DATA ARE EITHER INSUFFICIENT AND/OR CANNOT BE CONSIDERED AS DIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES WITHIN THE RESPECTIVE AREA.

B. THE AVAILABLE DATA PROVIDE INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

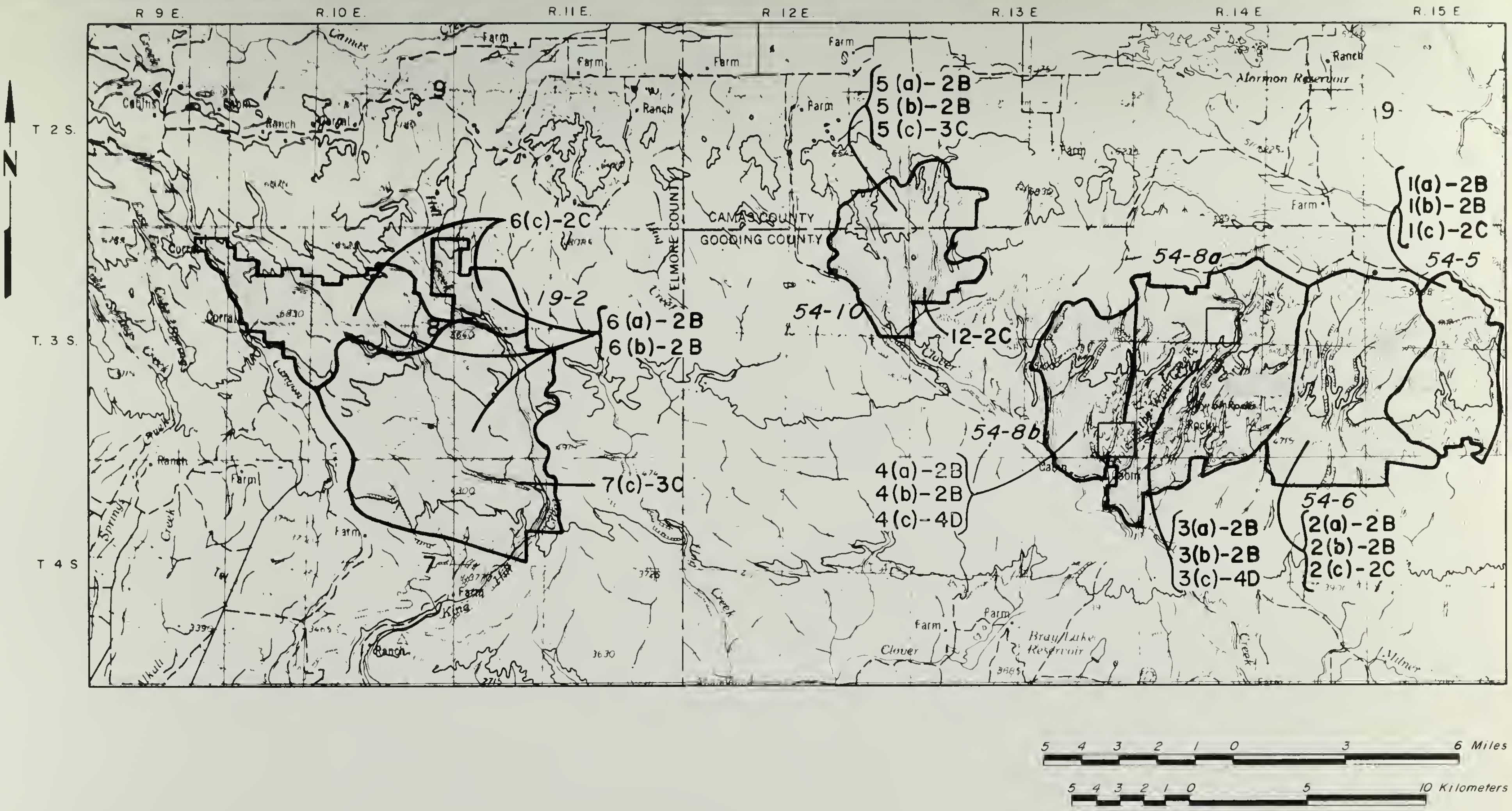
C. THE AVAILABLE DATA PROVIDE DIRECT EVIDENCE, BUT ARE QUANTITATIVLEY MINIMAL TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

D. THE AVAILABLE DATA PROVIDE ABUNDANT DIRECT AND INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES

EXPLANATION



a) Metallic Minerals
b) Uranium and Thorium
c) Non-Metallic Minerals



Approximate Boundary of Wilderness Study Area.

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Anchorage, Alaska

BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Mount Bennett Hills GRA,
Idaho
Wilderness Study Area
Land Classification
Locatable Resources

SCALE: 1" = 4 MILES (1:250,000)			FIGURE
DATA BY. WGM	DATE 9/1982	REVISED	13
DRWN BY. DSI	APRVD. G.F.		

Mount Bennett Hills GRA, Idaho
Legend For Figure 14

BLM LAND CLASSIFICATION SYSTEM FOR GEM RESOURCES

CLASSIFICATION SCHEME

1. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES DO NOT INDICATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

2. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES INDICATE LOW FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

3. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, AND THE REPORTED MINERAL OCCURRENCES INDICATE MODERATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

4. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, THE REPORTED MINERAL OCCURRENCES, AND THE KNOWN MINES OR DEPOSITS INDICATE HIGH FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

LEVELS OF CONFIDENCE

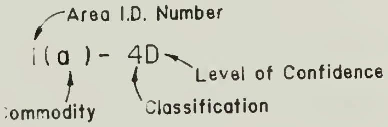
A. THE AVAILABLE DATA ARE EITHER INSUFFICIENT AND/OR CANNOT BE CONSIDERED AS DIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES WITHIN THE RESPECTIVE AREA.

B. THE AVAILABLE DATA PROVIDE INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

C. THE AVAILABLE DATA PROVIDE DIRECT EVIDENCE, BUT ARE QUANTITATIVLEY MINIMAL TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

D. THE AVAILABLE DATA PROVIDE ABUNDANT DIRECT AND INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

EXPLANATION

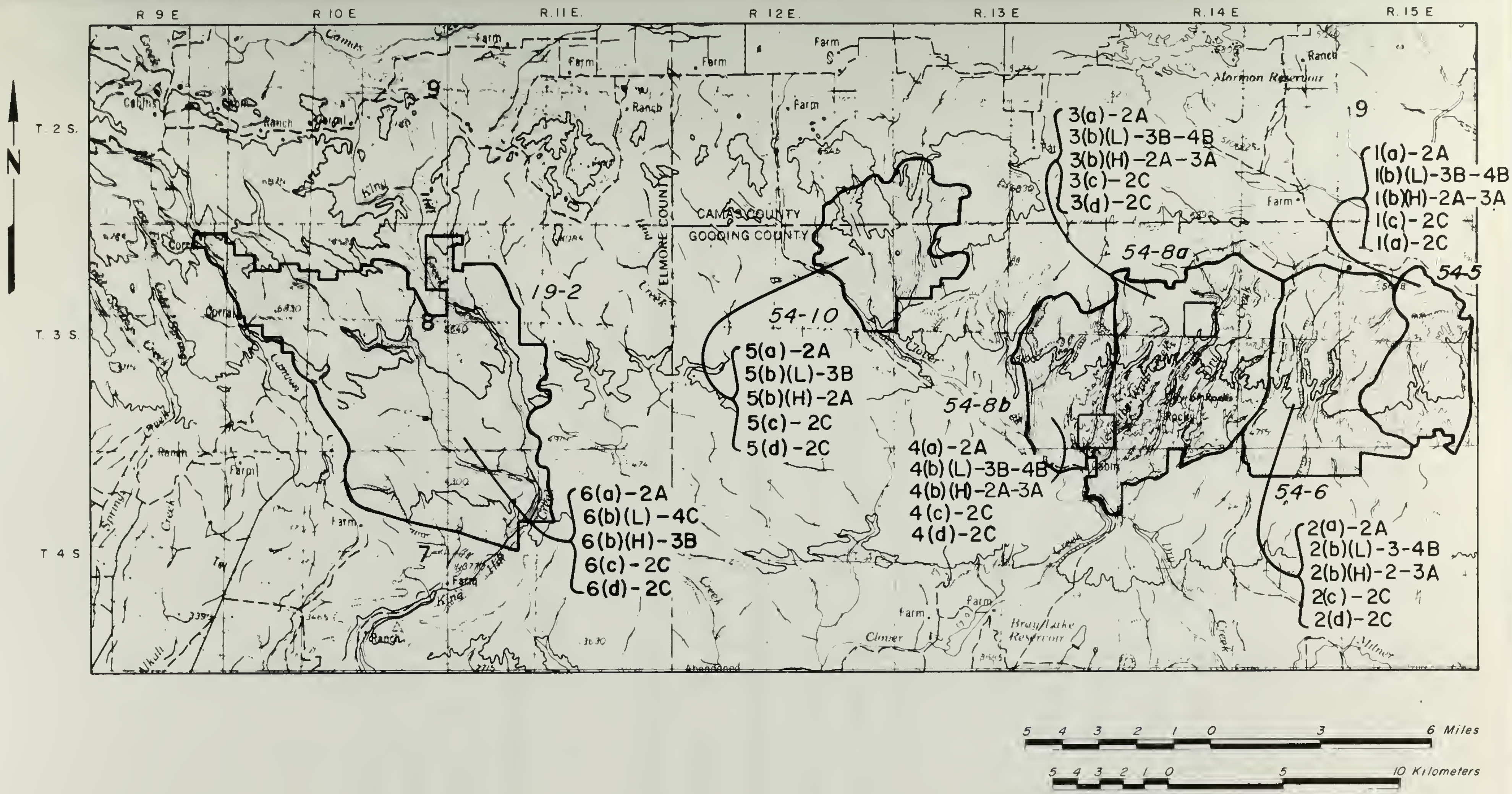


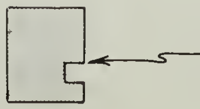
a) oil and gas

b) Geothermal: high temperature (H), Low temperature (L)

c) Sodium and Potassium

d) others: Asphalt (As) bitumen (bt), phosphate (ph), No specific commodity designation indicates that the rating applies to all of the above.





Approximate Boundary of Wilderness Study Area.

WGM Inc. Mining and Geological Consultants
Anchorage, Alaska

BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Mount Bennett Hills GRA, Idaho

Wilderness Study Area Land Classification Leasable Resources

SCALE: 1"= 4 MILES (1:250,000)		REVISED	FIGURE
DATA BY: WGM	DATE 9/1982		14
DRWN BY DSI	APRVD G.F		

Each WSA is classified for locatable, leasable, and saleable resources potential.

Locatable minerals are those which are locatable under the General Mining Law of 1872, as amended, and the Placer Act of 1870, as amended. Minerals which are locatable under these acts include metals, ores of metals, non-metallic minerals such as asbestos, barite, zeolites, graphite, uncommon varieties of sand, gravel, building stone, limestone, dolomite, pumice, pumicite, clay, magnesite, silica sand, etc. (Maley, 1983).

Leasable resources include those which may be acquired under the Mineral Leasing Act of 1920 as amended by the Acts of 1927, 1953, 1970, and 1976. Materials covered under this Act include: asphalt, bitumen, borates of sodium and potassium, carbonates of sodium and potassium, coal, natural gas, nitrates of sodium and potassium, oil, oil shale, phosphate, silicates of sodium and potassium, sulfates of sodium and potassium, geothermal resources, etc. (Maley, 1983).

Saleable resources include those which may be acquired under the Materials Act of 1947 as amended by the Acts of 1955 and 1962. Included under this Act are common varieties of sand, gravel, stone, cinders, pumice, pumicite, clay, limestone, dolomite, peat and petrified wood (Maley, 1983).

4.2 Classification of the Little City of Rocks Wilderness Study Area (WSA 54-5)

4.2.1 Locatable Resources

4.2.1a Metallic Minerals. Little City of Rocks (55-5) WSA (1a, Fig.13) is classified as having low potential for metallic mineral resources based on indirect evidence (2B). The basis of this classification is the data and concepts outlined in Section 3.5.

4.2.1b Uranium and Thorium. All of the Little City of Rocks (54-5) WSA (1b, Fig. 13) is classified as having low potential for uranium and thorium based on indirect evidence (2B). The basis of this classification is the data and concepts outlined in Section 3.5.

4.2.1b Non-Metallic Minerals. The Little City of Rocks (54-5) WSA (1c, Fig. 13) is classified as having low potential for non-metallic mineral resources based on a limited amount of direct evidence (2C). This classification is based on the absence of the Banbury Basalt in the WSA. The Banbury hosts the known deposits of diatomite in the area. Also there are no reported occurrences of non-metallic minerals in the Idavada volcanics which underlie all of the WSA.

4.2.2 Leasable Resources

4.2.2a Oil and gas. The Little City of Rocks (54-5) WSA (1a, Fig. 14) is classified as having low favorability for oil and gas resources, however the

data are considered insufficient to make a definitive evaluation (2A). The basis of this classification is the data and concepts outlined in Section 3.5.

4.2.2b Geothermal. The entire area of the Little City of Rocks (54-5) WSA (1b, Fig. 14) is classified as having moderate to high potential for low temperature geothermal resources based on indirect evidence (3B-4B). The area is classified as having low to moderate potential for high temperature resources but the data is insufficient for a definitive evaluation (2A-3A). The basis for this classification is discussed in Section 3.5.

4.2.2c Sodium and Potassium. All of the Little City of Rocks (54-5) WSA (1c, Fig. 14) is classified as having low potential for sodium and potassium based on limited direct evidence (2C). The basis of this classification is the unfavorable geologic environment of the WSA.

4.2.2d Other. The Little City of Rocks (54-5) WSA (1d, Fig. 14) is classified as having low potential for other leasable resources based on limited direct evidence (2C).

4.2.3 Saleable Resources. The Little City of Rocks (54-5) WSA (1, Fig. 15) is classified as having low potential for saleable resources, however the data are insufficient to make a definitive evaluation (2A).

Mount Bennett Hills GRA, Idaho
Legend For Figure 15

BLM LAND CLASSIFICATION SYSTEM FOR GEM RESOURCES

CLASSIFICATION SCHEME

1. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES DO NOT INDICATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

2. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES INDICATE LOW FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

3. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, AND THE REPORTED MINERAL OCCURRENCES INDICATE MODERATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

4. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, THE REPORTED MINERAL OCCURRENCES, AND THE KNOWN MINES OR DEPOSITS INDICATE HIGH FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

LEVELS OF CONFIDENCE

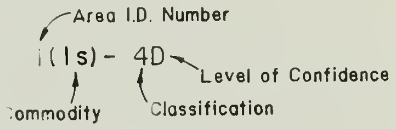
A. THE AVAILABLE DATA ARE EITHER INSUFFICIENT AND/OR CANNOT BE CONSIDERED AS DIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES WITHIN THE RESPECTIVE AREA.

B. THE AVAILABLE DATA PROVIDE INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

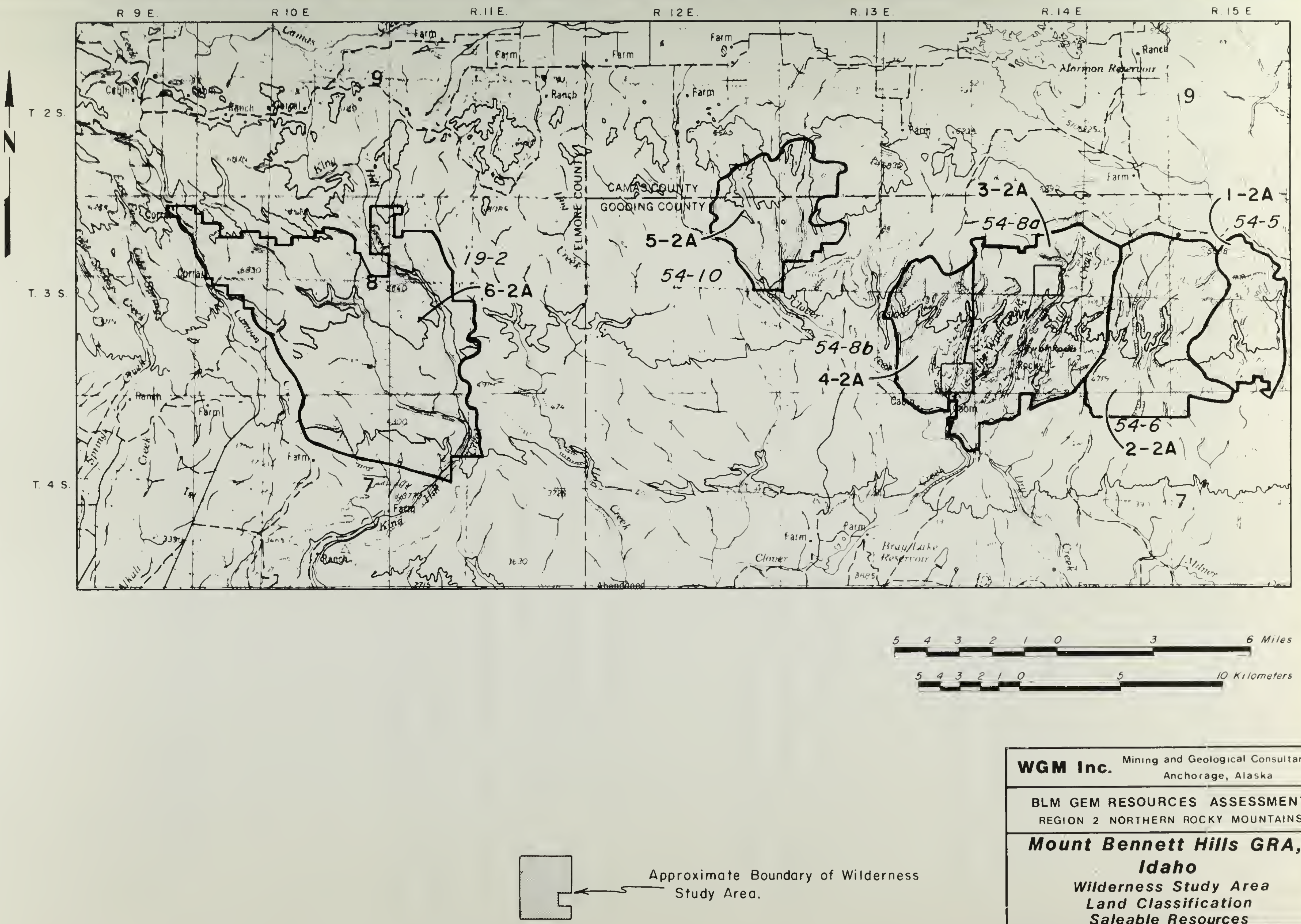
C. THE AVAILABLE DATA PROVIDE DIRECT EVIDENCE, BUT ARE QUANTITATIVLEY MINIMAL TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

D. THE AVAILABLE DATA PROVIDE ABUNDANT DIRECT AND INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

EXPLANATION



s	Sand
g	Gravel
st	Stone
c	Cinders
p	Pumice
pt	Pumicite
cl	Clay
Ls	Limestone
dl	Dolomite
P	Peat
pw	Petrified wood



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Anchorage, Alaska

BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Mount Bennett Hills GRA, Idaho

Wilderness Study Area
Land Classification
Saleable Resources

SCALE: 1" = 4 MILES (1:250,000)
DATA BY: WGM DATE 9/1982 REVISED
DRWN BY DSI APRVD G.F.
FIGURE 15

4.3 Classification of the Black Canyon Wilderness Study Area (54-6)

4.3.1 Locatable Resources

4.3.1a Metallic Minerals. All of the Black Canyon (54-6) WSA (2a, Fig. 13) is classified as having low potential for metallic mineral resources based on indirect evidence (2B). The basis of this classification is the data and concepts outlined in Section 3.5.

4.3.1b Uranium and Thorium. The Black Canyon (54-6) WSA (2b, Fig. 13) is classified as having low potential for uranium and thorium based on indirect evidence (2B). The basis of this classification is the data and concepts outlined in Section 3.5.

4.3.1c Non-Metallic Minerals. All of the Black Canyon (54-6) WSA (2c, Fig. 13) is classified as having low potential for non-metallic mineral resources based on a limited amount of direct evidence (2C). This classification is based on the absence of the Banbury Basalt within the WSA. It hosts the known deposits of diatomite in the area. There are no reported occurrences of non-metallic minerals in the Idavada volcanics which underlie all of the WSA.

4.3.2 Leasable Resources

4.3.2a Oil and Gas. The entire area of the Black Canyon (54-6) WSA (2a, Fig. 14) is classified as having low favorability for oil and gas resources,

however the data are considered insufficient to make a definitive evaluation (2A). The basis of this classification are the data and concepts outlined in Section 3.5.

4.3.2b Geothermal. The Black Canyon (54-6) WSA (2b, Fig. 14) is classified as having moderate to high potential for low temperature geothermal resources based on indirect evidence (3B-4B). The area is classified as having low to moderate potential for high temperature resources but the data is insufficient for a definitive evaluation (2A-3A). The basis for this classification is discussed in Section 3.5.

4.3.2c Sodium and Potassium. The Black Canyon (54-6) WSA (2c, Fig. 14) is classified as having low potential for sodium and potassium based on limited direct evidence (2C). The basis of this classification is the unfavorable geologic environment of the WSA.

4.3.2d Other. The entire area of the Black Canyon (54-6) WSA (2d, Fig. 14) is classified as having low potential for other leasable resources based on limited direct evidence (2C).

4.3.3 Saleable Resources. The Black Canyon (54-6) WSA (2, Fig. 15) is classified as having low potential for saleable resources, however the data are insufficient to make a definitive evaluation (2A).

4.4 Classification of the Gooding Wilderness Study Area (54-8a)

4.4.1 Locatable Resources

4.4.1a Metallic Minerals. All of the Gooding (54-8a) WSA (3a, Fig. 13) is classified as having low potential for metallic mineral resources based on indirect evidence (2B). The basis of this classification is the data and concepts outlined in Section 3.5.

4.4.1b Uranium and Thorium. The Gooding (54-8a) WSA (3b, Fig. 13) is classified as having low potential for uranium and thorium based on indirect evidence (2B). The basis of this classification is the data and concepts outlined in Section 3.5.

4.4.1c Non-Metallic Minerals. The Gooding (54-8a) WSA (3c, Fig. 13) is classified as having high potential for diatomite deposits based on direct evidence (4D). The basis of this classification is the presence of known diatomite deposits in the Banbury Basalt along Clover Creek. The Banbury is also present elsewhere in the WSA.

4.4.2 Leasable Resources

4.4.2a Oil and Gas. The entire area of the Gooding (54-8a) WSA (3a, Fig. 14) is classified as having low favorability for oil and gas resources, however the data are considered insufficient to make a definitive evaluation (2A). The basis of this classification is the data and concepts outlined in Section 3.5.

4.4.2b Geothermal. The Gooding (54-8a) WSA (3b, Fig. 14) is classified as having moderate to high potential for low temperature geothermal resources based on indirect evidence (3B-4B). The area is classified as having low to moderate potential for high temperature resources but the data is insufficient for a definitive evaluation (2-3A). The basis for this classification is discussed in Section 3.5.

4.4.2c Sodium and Potassium. The Gooding (54-8a) WSA (3c, Fig. 14) is classified as having low potential for sodium and potassium based on limited direct evidence (2C). The basis of this classification is the unfavorable geologic environment of the WSA.

4.4.2d Other. All of the Gooding (54-8a) WSA (3d, Fig. 14) is classified as having low potential for other leasable resources based on limited direct evidence (2C).

4.4.3 Saleable Resources. The Gooding (54-8a) WSA (3, Fig. 15) is classified as having low potential for saleable resources, however the data is insufficient to make a definitive evaluation (2A).

4.5 Classification of the City of Rocks (54-8b) Wilderness Study Area

4.5.1 Locatable Resources

4.5.1a Metallic Minerals. All of the City of Rocks (54-8b) WSA (4a, Fig. 13) is classified as having low potential for metallic mineral resources

based on indirect evidence (2B). The basis of this classification is the data and concepts outlined in Section 3.5.

4.5.1b Uranium and Thorium. The City of Rocks (54-8b) WSA (4b, Fig. 13) is classified as having low potential for uranium and thorium based on indirect evidence (2B). The basis of this classification is the data and concepts outlined in Section 3.5.

4.5.1c Non-Metallic Minerals. The City of Rocks (54-8b) WSA (4c, Fig. 13) is classified as having high potential for diatomite deposits based on direct evidence (4D). The basis for this classification is the presence of diatomite deposits within the Banbury Basalt which underlies much of the WSA.

4.5.2 Leasable Resources

4.5.2a Oil and Gas. All of the City of Rocks (54-8b) WSA (4a, Fig. 14) is classified as having low favorability for oil and gas resources, however the data are considered insufficient to make a definitive evaluation (2A). The basis of this classification are the data and concepts outlined in Section 3.5.

4.5.2b Geothermal. The City of Rocks (54-8b) WSA (4b, Fig. 14) is classified as having moderate to high potential for low temperature geothermal resources based on indirect evidence (3B-4B). The area is classified as having low to moderate potential for high temperature geothermal resources

but the data is insufficient for a definitive evaluation (2A-3A). The basis for this classification is discussed in Section 3.5.

4.5.2c Sodium and Potassium. The City of Rocks (54-8b) WSA (4c, Fig. 14) is classified as having low potential for sodium and potassium based on limited direct evidence (2C). The basis of this classification is the unfavorable geologic environment of the WSA.

4.5.2d Other. The City of Rocks (54-8b) WSA (4d, Fig. 14) is classified as having low potential for other leasable resources based on limited direct evidence (2C).

4.5.3 Saleable Resources. The City of Rocks (54-8b) WSA (4, Fig. 15) is classified as having low potential for saleable resources, however the data are insufficient to make a definitive evaluation (2A).

4.6 Classification of the Deer Creek (54-10) Wilderness Study Area

4.6.1 Locatable Resources

4.6.1a Metallic Minerals. The entire area of the Deer Creek (54-10) WSA (15a, Fig. 13) is classified as having low potential for metallic mineral resources based on indirect evidence (2B). The basis of this classification is the data and concepts outlined in Section 3.5.

4.6.1b Uranium and Thorium. The Deer Creek (54-10) WSA (5b, Fig. 13) is classified as having low potential for uranium and thorium based on indirect

evidence (2B). The basis of this classification is the data and concepts outlined in Section 3.5.

4.6.1c Non-Metallic Minerals. The Deer Creek (54-10) WSA (5c, Fig. 13) is classified as having moderate potential for diatomite deposits based on limited direct evidence (3C). The basis for this classification is the presence of diatomite deposits within the Banbury Basalt which underlies much of the WSA.

4.6.2 Leasable Resources

4.6.2a Oil and Gas. The Deer Creek (54-10) WSA (5a, Fig. 14) is classified as having low favorability for oil and gas resources, however the data are considered insufficient to make a definitive evaluation (2A). The basis of this classification is the data and concepts outlined in Section 3.5.

4.6.2b Geothermal. The Deer Creek (54-10) WSA (5b, Fig. 14) is classified as having moderate potential for low temperature geothermal resources based on indirect evidence (3B). The area is classified as having low potential for high temperature resources but the data is insufficient for a definitive evaluation (2A). The basis for this classification is discussed in Section 3.5.

4.6.2c Sodium and Potassium. The Deer Creek (54-10) WSA (5c, Fig. 15) is classified as having low potential for sodium and potassium based on limited direct evidence (2C). The basis of this classification is the unfavorable geologic environment of the WSA.

4.6.2d Other. The Deer Creek (54-10) WSA (5d, Fig. 15) is classified as having low potential for other leasable resources based on limited direct evidence (2C).

4.6.3 Saleable Resources. All of the Deer Creek (54-10) WSA (5, Fig. 15) is classified as having low potential for saleable resources, however the data are insufficient to make a definitive evaluation (2A).

4.7 Classification of the King Hill Creek (19-2) Wilderness Study Area

4.7.1 Locatable Resources

4.7.1a Metallic Minerals. All of the King Hill Creek (19-2) WSA (6a, Fig. 13) is classified as having low potential for metallic mineral resources based on indirect evidence (2B). The basis of this classification is the data and concepts outlined in Section 3.5.

4.7.1b Uranium and Thorium. The King Hill Creek (19-2) WSA (6b, Fig. 13) is classified as having low potential for uranium and thorium based on indirect evidence (2B). The basis of this classification is the data and concepts outlined in Section 3.5.

4.7.1c Non-Metallic Minerals. The southern portion of the King Hill Creek (19-2) WSA (7c, Fig. 13) is classified as having moderate potential for diatomite deposits based on limited direct evidence (3C). The remainder of the WSA (6c, Fig. 13) is classified as having low potential for diatomite

deposits based on limited direct evidence (2C). The basis for the classification is the occurrence of known diatomite deposits in the Banbury Basalt which underlies area 14. Area 6c is underlain by Idavada volcanics which are not known to host diatomite deposits.

4.7.2 Leasable Resources

4.7.2a Oil and Gas. The King Hill Creek (19-2) WSA (6a, Fig. 14) is classified as having low favorability for oil and gas resources, however the data are considered insufficient to make a definitive evaluation (2A). The basis of this classification is the data and concepts outlined in Section 3.5.

4.7.2b Geothermal. All of the King Hill Creek (19-2) WSA (6b, Fig. 14) is classified as having high potential for low temperature geothermal resources based on limited direct evidence (4C). The WSA is classified as having moderate potential for high temperature resources based on indirect evidence (3B). The basis for this classification is discussed in Section 3.5.

4.7.2c Sodium and Potassium. The King Hill Creek (19-2) WSA (6c, Fig. 14) is classified as having low potential for sodium and potassium based on limited direct evidence (2C). The basis of this classification is the unfavorable geologic environment of the WSA.

4.7.2d Other. The King Creek (19-2) WSA (6d, Fig. 14) is classified as having low potential for other leasable resources based on limited direct evidence (2C).

4.7.3 Saleable Resources. The King Hill Creek (19-2) WSA (6, Fig. 15) is classified as having low potential for saleable resources, however the data are insufficient to make a definitive evaluation (2A).

5.0 RECOMMENDATIONS FOR FURTHER WORK

The metallic minerals and uranium evaluation could be upgraded if geochemical sample data were available for the Mt. Bennett Hills GRA. Stream sediment and panned concentrate samples should be taken from all drainages in the GRA at a density of one sample per square mile. Sampling of the Volcano district should be done to provide a model of the geochemical signature of precious metal veins. The samples should be analyzed for copper, lead, zinc, molybdenum, silver, gold, and tungsten. The Department of Energy geochemical samples should be plotted on maps to determine if any are within the Mt. Bennett Hills GRA. If the number of samples is insufficient for evaluation purposes then any stream silt samples collected should also be analyzed for uranium.

Mapping by Malde and Powers (1972) indicates that diatomite deposits occur in the sedimentary portion of the Banbury Basalt. However, the sedimentary component of the Banbury is mapped only on a reconnaissance scale (Rember and Bennett, 1979). More detailed mapping (at least 1:24,000 scale) of areas underlain by Banbury Basalt should be done to determine the distribution of the diatomite depoists. This will allow better definition of areas within the WSAs which have non-metallic mineral resource potential.

The oil and gas evluation could be upgraded by completion of the following studies:

1. Detailed geophysical studies in the Western Snake River Plain should be made. These will allow the recognization of subsurface structures that could contain potential hydrocarbon reservoirs.

2. Hydrocarbon characterization and thermal maturity studies should be made of potential source beds from cuttings or core samples taken from deep tests in the western Plain. This will indicate the types of hydrocarbons to be anticipated from favorable beds in the area.

The geothermal evaluation of the WSAs will be complex because of the relatively unknown detailed geology, hydrology, and thermal character of the area. Evaluation of the more promising areas of the Little City of Rocks, Black Canyon, Gooding and City of Rocks WSAs as well as the King Hill Creek WSA would require detailed geologic mapping, structural analysis, geochemical sampling of spring waters, shallow gradient drilling, and intermediate temperature tests. A drilling program of five to ten 500-foot holes and one or more 1,500-3,000 foot holes would be necessary to complete the evaluation for each WSA.

6.0 REFERENCES AND SELECTED BIBLIOGRAPHY

Allen, R.M., 1940, Geology and ore deposits of the Volcano district, Elmore County, Idaho: Univ. of Idaho, M.S. Thesis, 43 p.

__________, 1952, Geology and mineralization of the Volcano district, Elmore County, Idaho: Econ. Geol., Vol. 47, No. 8, pp. 815-821.

Armstrong, F.C., 1964, Uranium in Mineral and Water Resources of Idaho: Idaho Bureau of Mines and Geology, Spec. Pub. No. 1, p. 233-239.

Armstrong, R.L., Harakel, J.E. and Neill, W.M., 1980, K-Ar dating of Snake River Plain (Idaho) volcanic rocks - new results: Isochron/west, No. 27, p. 5-10.

Armstrong, R.L., Leeman, W.P. and Malde, H.E., 1975, Quaternary and Neogene volcanic rocks of the Snake River Plain, Idaho: Am. Jour. Sci., Vol. 275, pp. 225-251.

Armstrong, R.L., Taubeneck, W.H. and Hales, P.O., 1977, Rb/Sr and K-Ar geochronometry of the Mesozoic granitic rocks and their Sr isotopic composition, Oregon, Washington and Idaho: Geol. Soc. America Bull., Vol. 88, p. 397-411.

Arney, B.H., 1982, Evidence of former higher temperatures from alteration minerals, Bostic 1-A Well, Mountain Home, Idaho: Geothermal Resources Council Trans., Vol. 6, pp. 3-6.

Arney, B.H., Goff, F. and Harding-Lawson Associates, 1981, Evaluation of the hot dry rock geothermal potential of an area near Mountain Home, Idaho: Los Alamos Natl. Laboratory, Rpt. LA-9365-HDR, 65 p.

Axelrod, D.I., 1964, The Miocene Trapper Creek flora of southern Idaho: Univ. of California Pubs. in Geological Sciences, Vol. 51, 180 p.

Ball, L., Sailsbury, J.W., Kintzinger, D.R., Veneruso, A.F. and Ward, S.H., 1979, The national geothermal exploration technology program: Geophysics, Vol. 44, pp. 1721-1737.

Bennett, E.H., 1980, Granitic rocks of Tertiary age in the Idaho batholith and their relation to mineralization: Econ. Geol., Vol. 75, pp. 278-288.

Bennett, E.H., Miller, M.M., Markland, T.R., Pitman, W.R., Lockard, D.W. and Peterson, J.G., 1982, Developments in minerals, mining and energy in Idaho for 1981: Idaho Bureau of Mines and Geology, Reprint 7, 18 p.

Bergendahl, M.H., 1964, Gold in Mineral and Water Resources of Idaho: Idaho Bureau of Mines and Geology, Spec. Rpt. No. 1, pp. 93-101.

Bonini, W.E. and Lavin, P.M., 1957, Gravity measurements in the western Snake River Plains, Idaho: Geol. Soc. America Bull., Vol. 68, pp. 1700-1708.

Breckenridge, R.M., 1982, Oil and gas exploration in Idaho: Idaho Bureau of Mines and Geology, 1 sheet.

Brott, C.A., Blackwell, D.D. and Mitchell, J.C., 1976, Geothermal investigations in Idaho, 8, heat flow study of the Snake River Plain, Idaho: Idaho Dept. of Water Resources, Water Inf. Bull. 30, 195 p.

Brott, C.A., Blackwell, D.D. and Ziagos, J.P., 1981, Thermal and tectonic implications of Heat flow in the eastern Snake River Plain, Idaho: J. Geophys. Res., Vol. 68, pp. 11709-11734.

Burke, K.C. and Dewey, J.F., 1973, Plume-generated triple junctions: key indicators in applying plate tectonics to old rocks: Jour. Geol., Vol. 81, pp. 406-433.

Butterman, W.C., 1980, Gold in Mineral Facts and Problems, 1980 Ed.: U.S. Bureau of Mines, Bull. 671, pp. 367-382.

Dee, L., 1982, Personnal communication, District Geologist, Shoshone BLM office.

Durham, D.L., 1973, Diatomite in Brobst, D.A. and Pratt, W.P., eds., United States Mineral Resources: U.S. Geol. Survey Prof. Paper 820, pp. 191-196.

Ellis, A.J. and Mahon, W.A.J., 1977, Chemistry and geothermal systems: Academic Press, New York, 329 p.

Evernden, J.F., Savage, D.E., Curtis, G.H. and James, G.T., 1964, Potassium-argon dates and the Cenozoic mammalian chronology of North America: Am. Jour. Sci., Vol. 262, p. 145-198.

Greeley, R., 1977, Basaltic "Plains" volcanism in Greeley, R. and King, J.S., ed., Volcanism of the Eastern Snake River Plain, Idaho: A Comparative Planetary Geology Guidebook: NASA Rpt. CR-154621, p. 23-44.

___________, 1982, The Snake River Plain, Idaho: Representative of a new category of volcanism: Jour. Geophys. Res., Vol. 87, No. B4, pp. 2705-2712.

Greeley, R. and King, J.S., 1977, Volcanism of the eastern Snake River Plain, Idaho: Office Planetary Geology National Aeronautics and Space Administration, Pub. CR-154621, 308 p.

Hamilton, S., 1982, Personal communication regarding AMAX Inc. exploration work at Big Southern Butte, Idaho.

Hodgson, C.J. and Lydon, J.W., 1977, Geological setting of volcanogenic massive sulfide deposits and active hydrothermal systems: Some implications for exploration: Can. Inst. Mining and Metall. Bull., Vol. 70, p. 95-106.

Hunt, C.B., 1974, Natural regions of the United States and Canada: W.H. Freeman and Company, p. 409-414.

Hustedde, G.S., Copeland, J.A., Strowd, W.B., Mitchell, V.E. and Bennett, E.H., 1981, Mines and prospects of Hailey Quadrangle, Idaho: Idaho Bureau of Mines and Geology, Mines and Prospects Map Series, 1:250,000 scale.

Hyndman, D.W., 1978, Major tectonic elements and tectonic problems along the line of section from northeastern Oregon to west-central Montana: Geol. Soc. America, Map and Chart Series, MC-28C, 11 p.

Hyndman, D.W., Tablot, J.L. and Chase, R.B., 1975, Boulder batholith: A result of emplacement of a block detached from the Idaho batholith infrastructure?: Geology, Vol. 3, p. 401-404.

Kadey, F.L., 1975, Diatomite in Industrial Minerals and Rocks, 4th ed.: American Inst. Mining, Metall. and Petrol. Engs., New York, pp. 605-635.

Lipman, P.W., Fisher, F.S., Mehnert, H.H., Naeser, C.W., Luedke, R.G. and Steven, T.A., 1976, Multiple ages of mid-Tertiary mineralization and alteration in the western San Juan Mountains: Econ. Geol., Vol. 71, pp. 571-588.

Mabey, D.R., 1976, Interpretation of a gravity profile across the western Snake River Plain, Idaho: Geology, Vol. 4, pp. 53-55.

Malde, H.E., 1959, Fault zone along the northern boundary of the western Snake River Plain, Idaho: Science, Vol. 130, p. 272.

Malde, H.E., 1965, Snake River Plain in Wright, H.E. and Frey, D.G. (eds.), The Quaternary of the United States, p. 255-263.

Malde, H.E. and Powers, H.A., 1962, Upper Cenozoic stratigraphy of western Snake River Plain, Idaho: Geol. Soc. America Bull., Vol. 73, No. 10, pp. 1197-1220.

______________________________, 1972, Geologic map of the Glenns Ferry-Hagerman Area, west-central Snake River Plain, Idaho: U.S. Geol. Survey, Misc. Geol. Inv. Map I-696, 2 sheets, scale 1:48,000.

Malde, H.E., Powers, H.A. and Marshall, C.H., 1963, Reconnaissance geologic map of west-central Snake River Plain, Idaho: U.S. Geol. Survey, Misc. Geol. Inv., Map I-373.

Maley, T., 1983, Handbook of mineral law: MMRC Publ., Boise, Idaho 293 p.

McBroome, L.A., Doherty, D.J. and Embree, G.F., 1981, Correlation of major Pliocene and Miocene ash-flow sheets, eastern Snake River Plain, Idaho: Montana Geol., Soc., 1981 Field Conf., southwest Montana, pp. 323-330.

McDowell, F.W. and Kulp, J.L., 1969, Potassium-argon dating of the Idaho batholith: Geol. Soc. America Bull., Vol. 80, pp. 2379-2382.

Meisinger, A.C., 1982, Diatomite in Minerals Year Book, Vol. 1, Metals and Minerals: U.S. Bureau of Mines, pp. 309-311.

Mitchell, A.H.G. and Garson, M.S., 1981, Mineral deposits and global tectonic settings: Academic Press, London, 405 p.

Mitchell, J.C., 1976, Geothermal investigations in Idaho, Part 7, Geochemistry and geologic setting of the geothermal waters of the Camas Prairie area, Blaine and Camas Counties, Idaho: Idaho Dept. of Water Res., Water Inf. Bull. 30, 44 p.

Mitchell, J.C., Johnson, L.L. and Anderson, J.E., 1980, Geothermal investigations in Idaho: Part 9, Potential for direct heat application of geothermal resources: Idaho Dept. of Water Resources, Water Inf. Bull. No. 30, 396 p.

Moreland, J.A., 1976, Digital model analysis of the effects of water use alternatives on spring discharges, Gooding and Jerome Counties, Idaho: Idaho Dept. of Water Resources, Water Inf. Bull. 42.

Morgan, W.J., 1972, Plate motions and deep mantle convection; in Shangam, et al. (eds.), Studies in Earth and Space Sciences (Hess volume): Geol. Soc. America, Memoir 132, pp. 7-22.

Muffler, L.J.P. (ed.), 1979, Assessment of geothermal resources of the United States, 1978: U.S. Geological Survey Circ. 790, 163.

Powers, H.A., 1947, Diatomite deposits of southwestern Idaho: Idaho Bureau of Mines and Geology, Mineral Resources Rpt., No. 4, 27 p.

____________, 1960, Alkalic lava flow, with fluidity of basalt, in the Snake River Plain, Idaho: U.S. Geol. Survey Prof. Paper 400-B, p. B-297.

Prestwich, S.M. and Mink, L.L., 1979, Snake River Plain geothermal exploration well: Geothermal Resources Council Trans., Vol. 3, pp. 549-552.

Protska, H.J., 1979, Buried Pliocene calderas of the eastern Snake River Plain (ESRP): EOS, Vol. 60, No. 46, p. 945.

Protska, H.J., McIntyre, D.H. and Skipp, B.E., 1977, Interrelations of lower Tertiary volcanic fields in northwestern interior United States: Geol. Soc. America Abstracts with Programs, Vol. 9, No. 6, p. 755-756.

Rember, W.C. and Bennett, E.H., 1979, Geologic map of the Hailey Quadrangle, Idaho: Idaho Bureau of Mines and Geology, Geologic Map Series, 1:250,000 scale.

Ross, S.H., 1971, Geothermal potential of Idaho: Idaho Bureau of Mines and Geology Geologic Map Series, 1:250,000 scale.

Sammel, E.A., 1979, Occurrence of low temperature geothermal waters in the United States in Muffler, L.J.P. (ed.), Assessment of the Geothermal Resources of the United States - 1978: U.S. Geol. Survey Circ. 790, pp 86-132.

Schmidt, D.L., 1960, Quaternary geology of the Bellevue area, Idaho: Univ. of Washington, Seattle, Ph.D. Thesis.

Siems, P.L. and Jones, R.W., 1977, The Challis Volcanic Field: A review (abs.): Geol. Soc. America, Abstracts with Programs, Vol. 9, No. 6, p. 762.

Singer, D.A. and Mosier, D.L., 1981, A review of regional mineral resource assessment methods: Econ. Geol., Vol. 76, No. 5, pp. 1006-1015.

Skinner, K.G., Dammann, A.A., Swift, R.E., Eyerly, G.B. and Shuck, G.R., 1944, Diatomites of the Pacific Northwest as filter aids: U.S. Bureau of Mines Bull. 460, 87 p.

Skipp, B., 1981, A synopsis of the structure and stratigraphy of south-central Idaho -- contributions by the U.S. Geol. Survey since 1975: Montana Geol. Society Field Conf. Southwest Montana, p. 365-372.

Smith, C.L., 1966, Geology of the eastern Mt. Bennett Hills, Camas, Gooding and Lincoln Counties, Idaho: Univ. of Idaho, Ph.D. Thesis, 129 p.

Smith, R.L., 1960, Ash flows: Geol. Soc. America Bull., Vol. 71, pp. 795-842.

Smith, R.L. and Bailey, R.A., 1968, Resurgent cauldrons, in Coats, R.R., Hay, R.L. and Anderson, C.A. (eds.) Studies in Volcanology: Geol. Soc. America Mem. 116, pp. 613-678.

Smith, R.B. and Christiansen, R.L., 1980, Yellowstone Park as a window on the earth's interior: Scientific American, Vol. 242, pp. 84-95.

Sparlin, J.A., Braile, L.W. and Smith, R.B., 1982, Crustal structure of the eastern Snake River Plain determined from ray trace modeling of seismic refraction data: Jour. of Geophysical Research, Vol. 87, No. B4, p. 2619-2633.

Staley, W.W., 1964, Diatomite in Mineral and Water Resources of Idaho: Idaho Bureau of Mines and Geology, Spec. Rpt. No. 1, pp. 74-79.

Stearns, H.T., Crandall, L. and Steward, W.G., 1938, Geology and ground water resources of the Snake River Plain in southeastern Idaho: U.S. Geol. Survey, Water Supply Paper 774, 268 p.

Taubeneck, W.H., 1971, Idaho batholith and its southern extension: Geol. Soc. America Bull., Vol. 82, pp. 1899-1928.

Treco Industries, Inc., 1974, Diatomaceous earth marketing plan presented to AIA: Treco Industries Private Report, 14 p.

U.S. Department of Energy, 1982, Hydrogeochemical and stream sediment reconnaissance basic data for the Hailey and Challis Quadrangles, Idaho: Dept. of Energy, Uranium Resource Evaluation Project Rpt. GJBX-55(82), K/UR-410, 91 p.

Walker, E.H., 1964, Subsurface geology of the National Reactor Testing Station, Idaho: U.S. Geol. Survey Bull. 1133-E, 22 p.

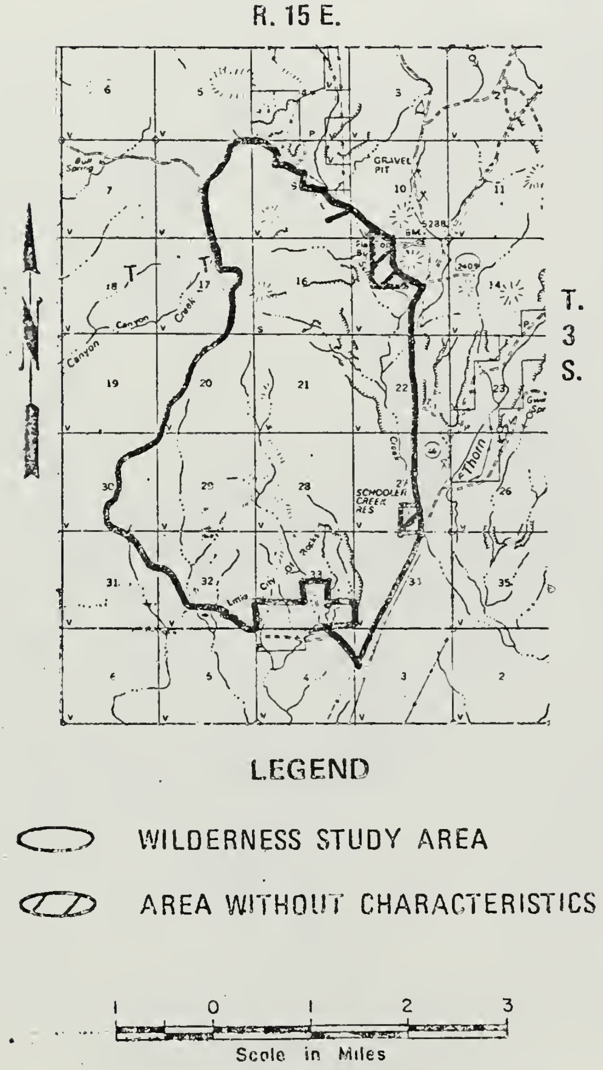
Walton, W.C., 1962, Ground water resources of Camas Prairie, Camas and Elmore Counties, Idaho: U.S. Geol. Survey, Water Supply Paper 1608, 57 p.

Williams, L.D., 1977, Petrology and petrography of a section across the Bitteroot lobe of the Idaho batholith: Univ. of Montana, Missoula, Ph.D. Thesis, 211 p.

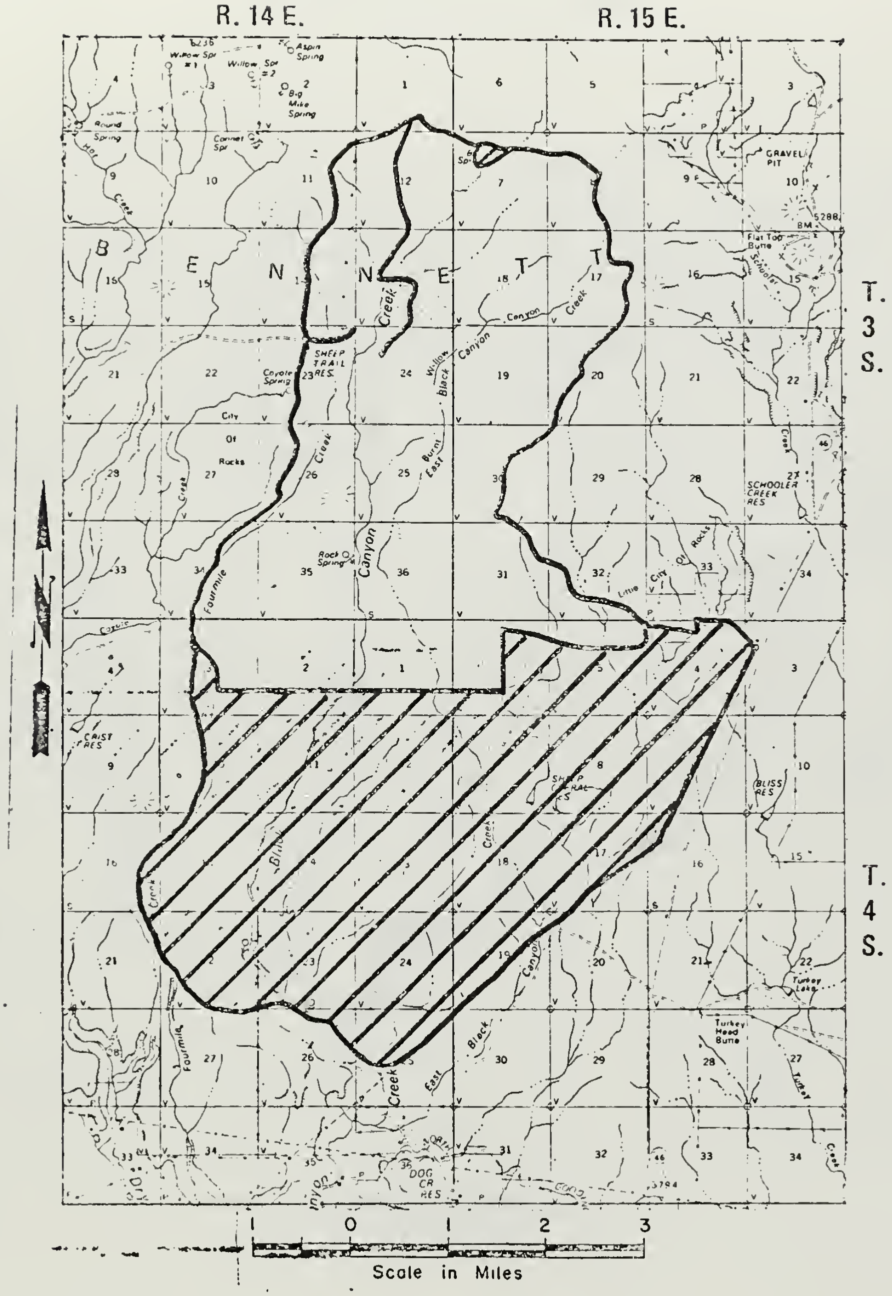
APPENDIX I

WILDERNESS STUDY AREA MAPS

54–5
LITTLE CITY OF ROCKS



54-6
BLACK CANYON

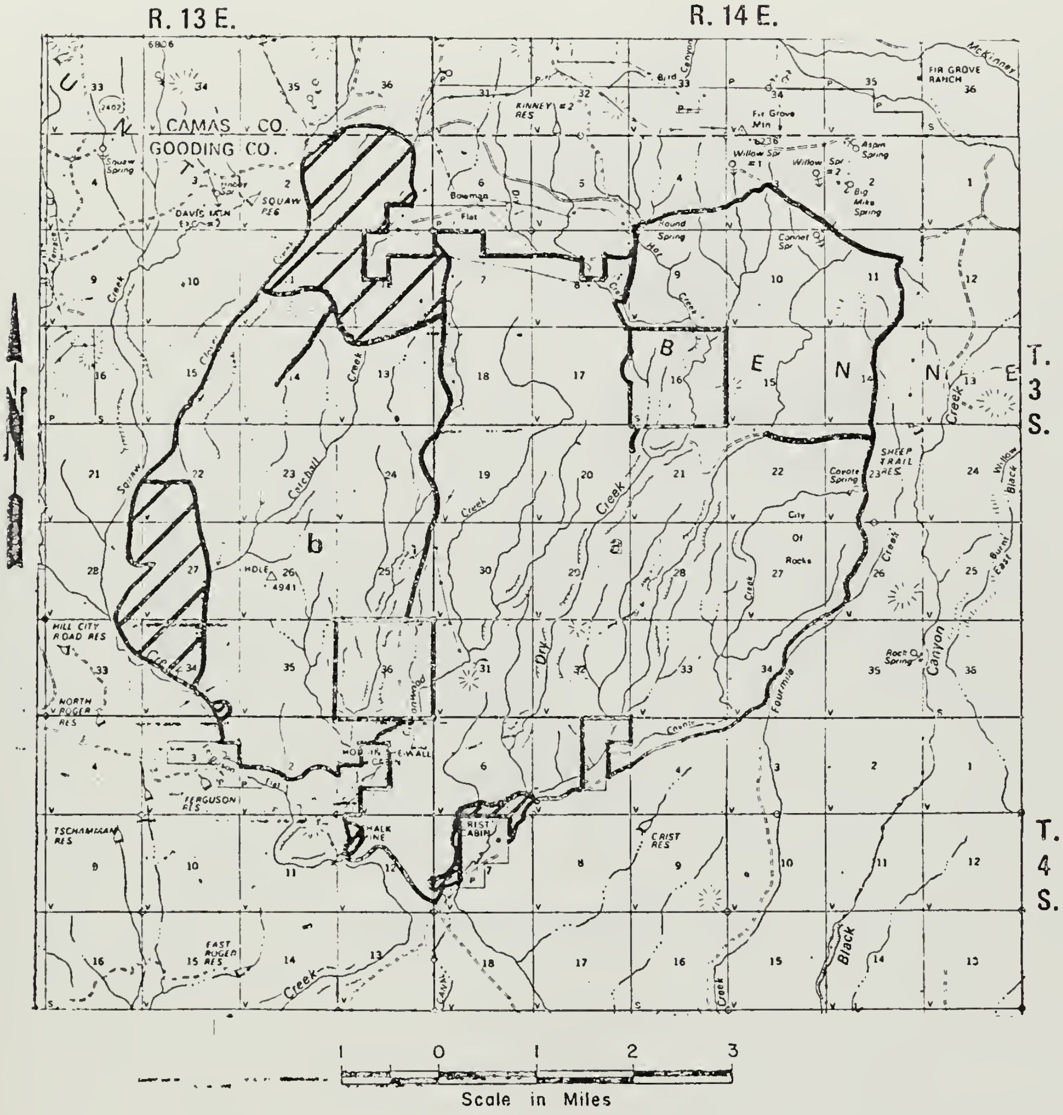


LEGEND

⬭ WILDERNESS STUDY AREA

▨ AREA WITHOUT CHARACTERISTICS

54–8 a,b
GOODING CITY OF ROCKS

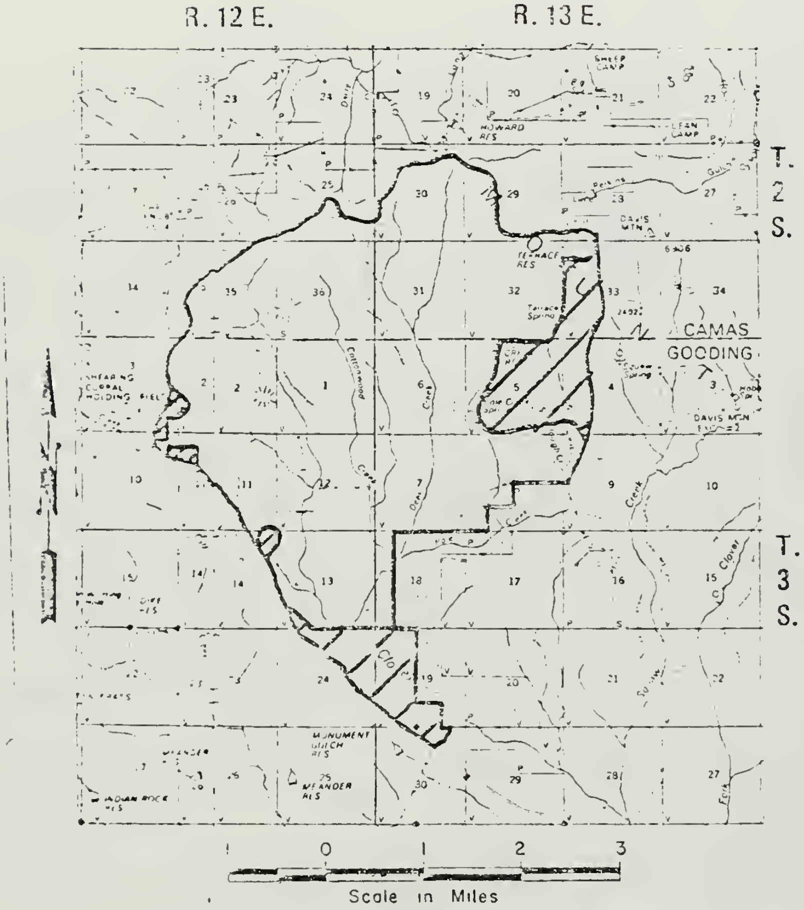


LEGEND

⬭ WILDERNESS STUDY AREA

▨ AREA WITHOUT CHARACTERISTICS

54–10
DEER CREEK



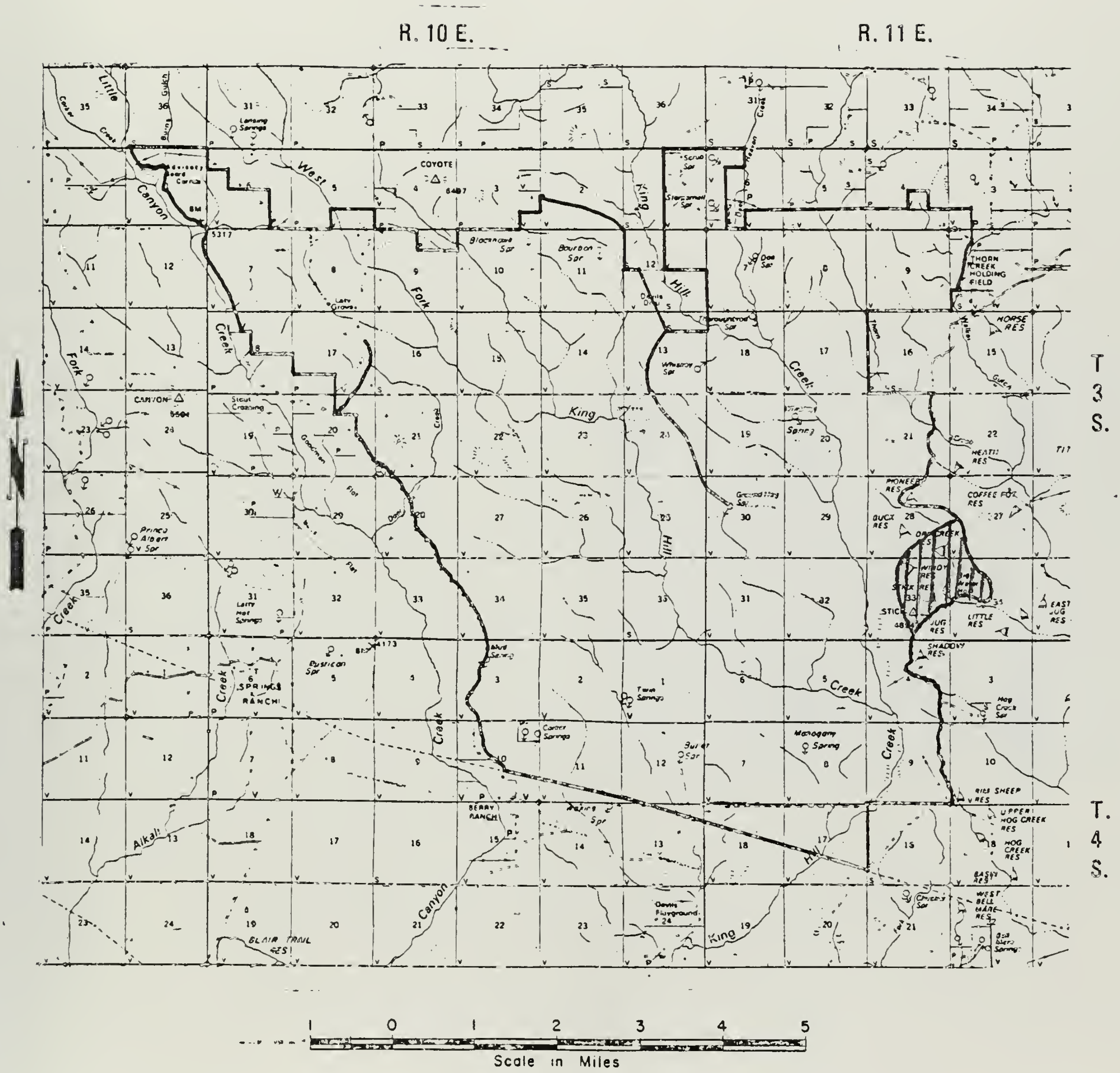
LEGEND

⬭ WILDERNESS STUDY AREA

▨ AREA WITHOUT CHARACTERISTICS

19-2

KING HILL CREEK



LEGEND

▭ WILDERNESS STUDY AREA

▨ AREA WITHOUT CHARACTERISTICS

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